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Goethals for City Manager Though it was not likely that Colonel Goethals would accept the position of city manager offered him by Dayton, Ohio, one cannot help thinking that American municipal government is looking upward when a body of conscientious, able men will turn to the most prominent administrator in the public eye to take up a large municipal burden. Looked at in the proper light, the management of a corporation as large as that of the city of Dayton, affecting 120,000 people, is a task well worthy of the best ability. That Dayton may secure a manager well equipped and worthy of the duties is the earnest wish of all friends of good government.

Building Code Revisions The passage by the City Council of Indianapolis of the building code which has been in course of preparation and under discussion for two years, brings to mind the work that the National Board of Fire Underwriters is doing for the improvement of building laws. Several years ago Prof. Ira H. Woolson, who had long been connected with Columbia University, specializing in fire resistance of materials, took up the work and has since given practically all of his time to it. His services are placed, gratis, at the disposal of towns and cities about to draft new codes, and at times weeks are spent on a single ordinance. In the case of Indianapolis a visit to the city for conference with the committee was also found advisable. While it may be true that eventually the insurance companies will make a gain commensurate with the outlay, the reward will be long delayed; for the real reward is not in the reduction of the number of small fires, which are but incidents of the day with insurance companies and which are properly provided for in rates measured by the risk, but in making conflagrations impossible. Evidently the changes which lessen this risk are slow; a generation must pass before the conflagration hazard is affected by the new code. The companies in aiding in these revisions, therefore, are carrying on a highly commendable missionary work, the returns from which will not materialize for years. The immediate rewards are reaped by the cities and towns accepting the service.

Safety on the Streets Unrestricted use of the highways has long since been denied in many communities, particularly since the advent of the automobile and the motor truck. Within cities the rules have necessarily become quite stringent in order that the safety of both pedestrians and vehicles might be secured. That the public means to have "safety first," in this particular at least, is apparent from the recent outcry in New York City against recklessness in driving mail trucks. These are privileged and are not bound by the ordinary traffic rules as to speed, stopping at crossings, passing of street cars, etc. Of late, the testimony indicates that these privileges have led to recklessness on the part of the drivers, resulting in a rapid increase in fatalities. An amendment was, therefore, introduced in the Board of Aldermen, revoking the privilege. It has received hearty support from citizens and officials who are in a position to know the perils which beset pedestrians, and has been opposed with equal vigor by the U. S. Post Office Department. The latter denies the correctness of the figures presented by the proponents of the amendment but bases its main argument on the delays which would result in handling mail were the mail trucks put on the same basis as other vehicles. The plea has little weight as against safety, but, to date, the Aldermen have not acted on the measure. The incident, no matter what the decision, points a salutary lesson. The public will have safety on its streets even if the U. S. Government must be deprived of a long-standing privilege.

Port Administration Elsewhere in this issue is an abstract of the inaugural address of Mr. Anthony G. Lyster, incoming president of the Institution of Civil Engineers, on the general subject of port administration. Mr. Lyster rightly sees the great importance to engineers of the larger, non-technical aspects, and with his long experience as engineer of the Mersey Dock Board is qualified as few others are to discuss the subject. His observations are based chiefly on British conditions, which are somewhat different from those obtaining in this country. Here, for instance, while private interests have had little to do with waterway developments, they evidently play a more important part in docking facilities than they do in England. In general, however, his observations are capable of universal application. Where the railways are in control he finds they treat the water terminals merely as adjuncts to their general transportation business and discriminate against rival companies. Municipal ownership means the injection of politics into the matter. Furthermore, it often happens that the geographical necessities point to lines of development outside of the limits of the municipality, and in such cases the local and the outside interests of the port conflict. As to Government ownership, the greatest drawbacks are that the Government is occupied with problems of greater political interest, that the authorities are not in intimate connection with the affairs of the individual port, and that the machinery to execute new projects is too slow. Mr. Lyster's conclusion is that the best results are obtainable from a commission made up of representatives of all of the large interests concerned—men at once capable, versed in the local affairs, and financially involved, directly or indirectly. In the case of general river improvement, where, as he says, there is a greater diversity of interests and problems than in any other form of dock or port enterprise, he strongly urges conservancy boards. Such boards can exert general control over the whole situation, harmonize clashing interests, prevent the diversion at the headwaters of water needed farther down for navigation purposes and be of invaluable service in collecting and recording engineering data and supervising research work.

Columbus Flood Measures The defeat of the bond issue for the construction of flood prevention works in Columbus has naturally aroused considerable interest both in Ohio and elsewhere. With the occurrences of last spring in mind it appears to those who have not followed the discussion that the citizens have grown indifferent to the perils which so recently beset them. This would probably be denied in Columbus. Nevertheless a matter of money has been allowed to put off the day when the city can feel confident of its safety. There seem to have been a number of factors in bringing about the defeat of the measure, which received a majority vote but not the two-thirds necessary for the authorization of the issue. Probably the most influential factor was the feeling that legislation will shortly provide for the formation of tax districts covering an entire watershed, thus spreading the cost over many communities and counties. The governor of Ohio has stated that, in his opinion, legislation can be secured if influential communities will unite on a definite program. Undoubtedly, too, the proposal to provide for payment of the bonds and the interest thereon by assessment against all property in the city regardless of location stirred up considerable opposition. It had been proposed that part of the money be raised by special assessment on the properties likely to be affected by floods and the remainder provided by the city as a whole, but this plan was rejected by the officials. Finally, the indecision of the officials in accepting a definite plan undoubtedly had some influence on the result. It is regrettable that the capital city of the State hardest hit last spring should have failed to take prompt action on the remedial measures proposed. To justify the result by the conflicting considerations before the voters and to claim that the verdict was just in view of the conditions attached to the issue will be of no value if the coming spring brings floods for which the city is not, but could have been, prepared had vigorous policies prevailed. In a predicament such as that of Columbus firm handling of the situation is necessary. If nothing can be done until participation of other communities is provided for by legislation, agitation and education along those lines should be begun at once, for unless there is strong public sentiment pointing the way legislative wheels are likely to move slowly.

Logging Engineering New branches of engineering appear frequently in these progressive times. Usually they result from the subdivision of more general subjects. Occasionally, however, the development is synthetic rather than analytic, and some modern need is supplied by combining a number of specialties in an entirely new relationship. Logging engineering is not a brand new term in timber districts, but it is a branch of engineering which is just beginning to come into its own. In the early days of the lumber industry it was a comparatively simple matter to get logs to the mill. Only that timber convenient to easy transportation facilities was cut, because it was cheaper to move to a new district than to work very far back from the shore line. This produced scarcity of timber along the river banks and the shores of inlets, but the demand for lumber increased tenfold and the price went up so that it began to be profitable to cut farther back and allow more and more for transporting the logs to water. Thus the difficulties of logging have so increased that instead of the simple and inexpensive methods of early times the modern logger must skillfully devise means of getting logs out of inaccessible places, must compare costs of steam and electric power in operating a system of cableways, must consider different methods of yarding and determine whether aerial skidding will be economical, must advantageously lay out skid roads and railroads and plan for log dumps, chutes, flumes and booms. In all of these he must be certain to select the methods which will deliver the logs most economically. These problems come under a new head; there is no parallel branch of engineering from which men can readily step into this new field. Because this is so the logging industry has suffered from the shortage of men skilled in the engineering which its modern methods involve. Mr. E. P. Blake, president of the Logging Congress, in his opening address at the recent meeting in Spokane, laid stress on the present need for the logging engineer, and voiced the opinion that if the organization had the courage of its convictions upon this point it would not adjourn until definite steps had been taken to endow at least one chair of logging engineering. It is to be noted that the action taken by the Logging Congress was to appoint a committee to outline a course in that subject. The committee already has the outline of such a course in the paper read by Mr. O'Hearne, an abstract of which appeared in the Engineering Record of Nov. 15, page 549. The committee will probably not look upon the perfecting of such an outline as its sole function; it will likely endeavor to secure such recognition for logging engineering as a profession that Western colleges will provide the needed instruction.

Bureau of Standards

It is probably a safe statement that engineers as a whole fail to appreciate that variety and character of the work done by the U. S. Bureau of Standards. A "Circular" of the Bureau, just off the press, entitled "The Testing of Materials," gives an excellent idea of the scope of the work. The purpose of the circular, which is, in fact, a 6 x 9-in. pamphlet of 90 pages, is to outline for the information of the user or buyer of materials the tests usually made with respect to each class of goods, the conditions under which testing work is undertaken and some of the limitations due to the status of technical knowledge. Many of the materials discussed are not in use in engineering work, but among those so used are metals, cement, sand, clay, lime, sand-lime brick, stone, paints, lubricating oils, bituminous materials, rubber, and water. While with respect to some materials specifications have been definite for a long time, with reference to others the Bureau has done pioneer work. Often desired qualities were known only from the more or less definite impressions of workmen; in other cases the relations between the desired qualities and the physical and chemical properties were unknown. In some materials, such as lubricating oils, the end is not yet. In others, paper for example, of which the Government is the largest purchaser in the country, the investigations have proceeded somewhat near finality and quite complete specifications have been drawn. In the case of lime, regarding which a 130-page "Technologic Paper" has just been issued, the industry itself was sadly lacking in data required for the writing of specifications and in knowledge of the reasons for variations in quality of product. This, moreover, is not an isolated case. Many instances might be cited where the first impulse for the scientific study of the products of an industry came through the efforts of the Bureau to write specifications for the Government. Approaching each subject in a scientific spirit, yet with eyes and ears open for the aid to be received from industries and practical men, the staff of the Bureau has won an enviable reputation for fairness and ability. Its work in the field of structural engineering is expanding rapidly, and with it will undoubtedly come a better appreciation of the Bureau by the civil engineer. The work on concrete is well known, while a series of column tests in co-operation with a committee of the American Society of Civil Engineers is about to be undertaken.

These activities are worth bearing in mind, for the extension of the Bureau's activities is dependent both upon the value of the work and its appreciation by those who can benefit by the results. The intrinsic value, moreover, can be much enhanced by the hearty co-operation and backing of engineers, scientists and manufacturers.

Limitations of Efficiency Studies

There has recently come to the Engineering Record a report, by a well-known firm of efficiency engineers, on the organization and operation of a city engineer's office and with it a reply by the head of the department studied. A perusal of the documents prompts certain observations on the limitations of efficiency studies, so far as they relate to organizations of this type.

Efficiency studies, made with a view to standardizing conditions and methods, are most applicable to oft-repeated, closely supervised work. The constant repetition of the same operation affords an excellent opportunity for careful time and motion studies, and the scrutiny of all such adjuncts as planning, accurate record keeping and the effect of instruction on the output of the employee. As soon, however, as the work is less closely supervised and the proportion of repeated operations become less, difficulties begin to appear. They increase rapidly as the other extreme—no repetition and no supervision—is reached, and when, going even a step farther, the work becomes of an intellectual character standardization becomes impossible.

These facts are well appreciated by experienced students of industrial efficiency, but the fact that even in a designing office there are some more or less mechanical duties always holds out to the inexperienced the temptation to overstep the bounds and apply to the one process methods strictly applicable only to the other. For instance, there is always a considerable amount of filing, record-keeping and other routine work which lends itself very well to standardization, while the scattering of work in various offices and departments may often afford opportunity, if not for savings, at least for more effective work. When, however, the intellectual processes are likely to be affected by changes in personnel and organization it is time to call a halt and investigate the ideals which should animate the designing and construction staffs. Only one trained in the work dares go beyond this point, and even he, if a stranger to the organization, needs at every step the hearty co-operation of the department itself. Only a joint study is certain beyond this point to render any aid—and then it is more likely to come through the development by the organization itself of the thoughts suggested by the queries of the investigator than by the work of the stranger himself. Elaboration of this thought is not necessary for those who have even elementary notions of the mental process through which an engineer passes in determining all except the most elementary designs. Evidently the efficiency of a man designing a $100,000 concrete viaduct is not to be measured by the time he spends on the design. One man might finish it in a week, while another spending two weeks might effect a saving of $10,000 or $15,000, at the cost only of an extra week's salary.

Finally, it must be borne in mind that no work of this character will be successful unless there is mutual confidence between the investigated and the investigator, and a willingness on the part of the latter to give information and counter suggestions. Confidence must rest primarily upon ability and knowledge. These need not necessarily be in the lines of the major duties of the business studied, but if not the studies should be confined to those elements in which the investigator is qualified. Very likely certain of the practices affecting the intellectual or highly technical work of the office will be questioned—but at this point the limitations above pointed out should be realized and the work conducted accordingly. Any other plan will certainly lead to hard feeling on both sides, resulting in losses to each—the one in reputation and opportunity for accomplishment, the other in economies which a wise conduct of the work and hearty co-operation might have disclosed.

Call to Action in Iowa

The revamping of building ordinances in Iowa cities, following the recent building failure in Cedar Rapids, will undoubtedly occupy the attention of many councils during the coming winter. No more opportune time will ever present itself for engineers and architects to throw themselves into civic work and to guide the discussions into reasonable channels. With the daily newspapers full of engineering terms relating to stresses, factors of safety, form work and the effect of low temperature on concrete, technical men should lend all possible assistance to those who are so aroused that something constructive can be done.

Regardless of the cause of and responsibility for the failure at Cedar Rapids, a definite starting point for action has been marked. No higher service can be rendered to the state by the technical societies than to assist in framing and passing adequate building ordinances.

Last winter at the Sioux City meeting of the Iowa Engineering Society Mr. J. A. G. Sweimler, chairman of the committee on structural engineering, reported, with reference to building laws, that the State of Iowa had no laws covering the subject but left the matter to be handled entirely by city ordinances. Seven cities replied to questions relating to inspectors, their qualifications and the approval of plans. One stated that no qualifications were specified for inspectors, and that no provisions were made for inspecting construction. One had an ordinance requiring approval of plans by the Board of Public Works, but nothing further. A third city had an inadequate ordinance and a fourth stated that no ordinance existed. Two stated that they saw the need but that cities of their class were not allowed by the State to pass building ordinances. Help was asked to change this intolerable condition. After recounting the failures of the Alameda Hotel in Kansas City, the garage in Detroit and the theater in Cincinnati, Mr. Sweimler urged the necessity of good building codes and of competent engineers to carry them out.

It is to be hoped that the society's committee is now engaged in studying building codes and that when the Council Bluffs meeting is held in February a report will be presented on which definite constructive action can be taken. The day of the perfunctory report is past, for no more can the almost prophetic sentence in last year's report be repeated: "We cannot call your attention to any disastrous failures in Iowa, but this is not saying that there never will be any if something is not done to prevent them." It is to be regretted that the society has not the machinery for getting quicker action.

A Long Step Toward a Sane Water-Power Policy

The action of the National Conservation Congress at Washington last week in adopting the unanimous recommendations of the water-power committee marks a long step toward a sane water-power policy; not that the views of the Congress are binding on anyone—least of all upon the Federal Congress, by whose action, especially, the recommendations can be given effect—but because they stand forth as the unanimous opinion of both the conservatives and the radicals in water-power matters. Heretofore the proposal of laws regulating power development was sure to precipitate a fight even on the basic principles. Now, however, the two sides have subscribed to certain principles that are agreed to be essential. The points of difference were on details and in the spirit in which the various advocates approached the problem.

The recommendations approved by the Congress do not come as bolts out of the blue. They have been developing for some years, as is evidenced by the successive steps in permits issued by the Department of the Interior, culminating in the Pend d'Oreille permit of July 29, 1913, reviewed in this journal on Aug. 9 of this year. The very great step in advance, however, was the recognition by all parties of the utter folly of the present laws providing, in the case of developments on public lands, a permit revocable at will by the granting officer, and, in the case of powers on navigable streams, a fifty-year permit without provision for renewal. The recommendations, which will be found in full on page 601, declare that "for a definite period, sufficient to be financially attractive to investors, the privilege shall be irrevocable except for cause, reviewable by the courts." The failure of existing laws to make some such provision is responsible for the backwardness of present development. Capital will not be hazarded freely under such terms, and the wonder is that so much work has been done.

As a further protection to capital, provision for purchasing the property at a fair valuation is made. At the same time the public is adequately protected and the Government's fundamental title to the property placed beyond the shadow of a doubt. Rates come up for readjustment each decade, after the irrevocable period has passed, while an annual payment to the Government is to be made, varying in amount in accordance with conditions. Speculation in sites is discouraged by providing that the development shall proceed toward full capacity as rapidly as the granting officer may require, due consideration being given to market and other conditions.

While nothing but commendation can be offered these resolutions, protecting as they do the Government, the public and the investor, just a word may be said about the conditions attendant upon their adoption, for it will throw side-lights on the situation.

One would naturally expect that a report of such importance would have been very thoroughly discussed as to its intrinsic merits. Such, however, was not the case. There seemed to be general agreement on the unanimous recommendations of the committee and a broader issue was allowed to overshadow the meeting. The lines were drawn upon the "States' rights" issue—whether the States or the Federal Government should exercise control over water-power on non-navigable streams. The battle on this question waged the whole day and the decisive vote, about 450 to 150, was with the Federal control advocates. Their victory came in defeating a motion to send the recommendations to the resolutions committee. Nevertheless, the recommendations as adopted are equally as applicable to State as to Federal control.

One feature of the work of the committee is to be deplored—that after unanimously agreeing upon the essentials, they were not made the sole report of the committee. The bringing in, in addition, of both majority and minority reports, only beclouded the issue, without contributing anything of value. The differences, except in the castigation of the power interests in the introduction to the minority report, are very slight.

The adoption of the recommendations, however, is only the first step. If they remain merely as the views of the Congress their influence on actual power development will be small. It behooves engineers, public service commissions and right-thinking citizens to do what they can to have them placed upon the statute books. Suitable bills will be introduced in the National Congress in the regular session. They will need support. Engineers can do their part in influencing the local press and engineering societies.

Technical Museums and the History of Engineering

The advocacy of a museum of engineering in this country has long passed the stage of novelty, but the announcement in New York last week that steps had been taken to found such an institution and that already a considerable fund had been subscribed warrants further consideration of the subject, and also of the allied topic, the history of engineering.

As will be remembered, the Germans have already pointed the way in this work. The Deutsches Museum, in Munich, after having expanded into two large rented buildings, has come into a large, handsome structure built especially for its purposes, while collaterally the Verein Deutscher Ingenieure has been carrying on historical researches that have resulted in embodying in written form developments which otherwise would shortly have gone into the realm of tradition, or have been left to repose in documents, which, as is the way with such repositories of historical data, are likely to be destroyed or at least forgotten.

So important is this work regarded in Germany that no technical education is considered complete without courses in technical history. The purpose is twofold: to inspire young men by a recital of the achievements of those who placed engineering where it is to-day, and to open to them the storehouses of historical information, so that by studying past practice they may avoid methods that have proved unsuccessful and apply to new problems means of demonstrated value, but which in the march of events may have been temporarily discarded.

Just what the latter object means can be well appreciated from a passage of the address by Capt. Robert W. Hunt in accepting the John Fritz medal last December. "While overcoming the many difficulties which we encountered in perfecting the Bessemer process," he said, "and making it and its products successful both technically and financially, we demonstrated the value of numerous details, the importance of some of which seem to have later been lost sight of, until they are now being, in some instances, rediscovered and hailed as heretofore unknown truths. However, if their importance shall thus again become recognized, and beneficial results be obtained, good will have been accompished, but perhaps seeking information from history might be a less costly way of finding facts."

That the need both of a museum and of studies in the history of engineering is being appreciated on this side of the Atlantic might be shown by many quotations. The presidential address by Dr. A. C. Humphreys before the American Society of Mechanical Engineers last year emphasized their need, while a committee of the same society has been making efforts for some time to arouse the interest of members. The sentiment of the committee as well expressed in their report. "America owes its greatness," it reads, "to the buoyant courage and skill with which its artisans and engineers accepted and solved the new and gigantic problems which the conquest of a new continent imposed. Their clear conception, untrammeled by traditions and their cheerful, unremitting labor have built up, from a mere fringe of agricultural colonies on the seaboard, the greatest industrial community the world has yet seen, and that in the short space of but little more than a single century. The doing has so absorbed our energies that no one has found time for the recording. We who profit by the labors of these pioneers owe them the searching out and preserving of the records of their work. . . . Our main effort should be to preserve the landmarks of our journey to a higher civilization and thus write in enduring materials of our own fashioning the true history of the American people."

This being the temper of the American engineering mind to-day the plan just proposed should meet with hearty response. The plans, moreover, are on a scale far more ambitious than all but the most far-seeing would have dreamed of. The scheme is to have, eventually, a group of twenty buildings to be known collectively as the "Museums of the Peaceful Arts." Tentatively twenty groups of subjects have been fixed upon: electricity, steam, astronomy and navigation, safety appliances, aviation, mechanical arts, agriculture, mining, labor, efficiency, historic records, health and hygiene, textiles, ceramics and clays, architecture, scenic embellishment, gardening, roads and road building materials, commerce and trade, printing and books. There is also to be a central library covering the topics with which the various museums are concerned. It is manifest that the complete development will necessarily not come within the first few years, but the assurance that goodly-sized funds have already been pledged to the American Committee for the Celebration of the One-Hundredth Anniversary of Peace Among English-Speaking Peoples, which has planned the museums as a memorial of the anniversary, indicates that early results in a preliminary way may be looked for.

Progress of Tunkhannock Viaduct Construction on D., L. & W. Relocation

Continuous Concreting of Piers, More Than 200 Feet High, and Adjustable Steel Truss Centers for 180-Foot Arch Spans

THE highest concrete bridge of which there is record in the annals of engineering, and the largest of its kind in point of volume of masonry—the great Tunkhannock double-track viaduct for the Delaware, Lackawanna & Western Railroad—is beginning to take shape across the valley of Tunkhannock Creek near Nicholson, Pa. The structure, a link in the 43-mile relocation between Scranton, Pa., and Elmira, N. Y., is 300 ft. high from parapet to foundation (240 ft. above the surface of the creek) and has a length of 2230 ft. It will consist of twelve arches—ten of 180-ft. span and two of 100-ft. span—and will contain about 169,000 cu. yd. of concrete masonry. Since the substructure of the Tunkhannock viaduct was described in the Engineering Record of May 3, 1913, page 484, construction of the main piers has been progressing rapidly and the work of placing concrete for the arch spans is under way. The excavations have been carried, in open cofferdams, through sand, gravel and boulders to a depth of 60 ft. below ground-water level. Large masses of monolithic concrete have been placed continuously, most of the piers have been built to a maximum height of about 220 ft. above their footings, umbrella construction of the arch rib skewbacks integral with the piers has progressed and the steel truss arch centers, erected and supported without the use of falsework, have been fabricated and placed in position.

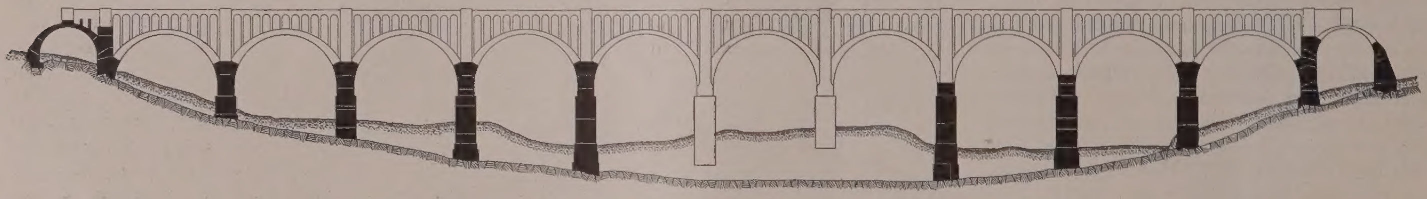


Diagram of Progress of Construction of Tunkhannock Viaduct up to October 1

Finished work is shown solid black; white lines indicate months

Difficult Pier Footings

The excavation for pier 4, which was interrupted in order to carry pier 3 beyond danger from floods, was completed after all of the other piers, except 5, 6 and 7, had been finished. The piers have been built in a 46 x 52-ft. open cofferdam for the lower section and a 54 x 60-ft. cofferdam for the top section, made by driving two successive tiers of Lackawanna steel sheet piles 30 ft. long. When excavation with a Williams clamshell bucket had reached within about 12 ft. of the rock the work was divided into two parts by a transverse cofferdam made of sheet piles about 12 ft. long, driven across the excavation about one-third of the distance from one end to the other. This was done to control the inflow of water and pressures.

A 4 x 8-ft. sump was sunk at the middle of the cofferdam in the large part of the excavation and the water conducted to it through permanent wooden drains laid close to the steel sheeting. The sump was drained by one 12-in. and two 6-in. centrifugal pumps with a combined capacity of about 200,000 gal. per hour, which delivered a continuous stream of water about 18 in. in diameter and kept the excavation dry, enabling the rock to be examined and prepared and the concrete to be deposited on it around the sump to a height above ground-water level. The sump was then sealed with concrete deposited under water and filled solid above the seal with concrete deposited in the dry.

On the other side of the wooden cofferdam the area of the excavation was divided into two parts, each of about one-sixth the total area of the foundation, which were excavated separately and concreted at the same time as the rest of the pier footing already described. About $15,000 worth of steel sheet piles was used on the work. They were pulled and redriven several times for the consruction of the successive piers.

Concreting Piers

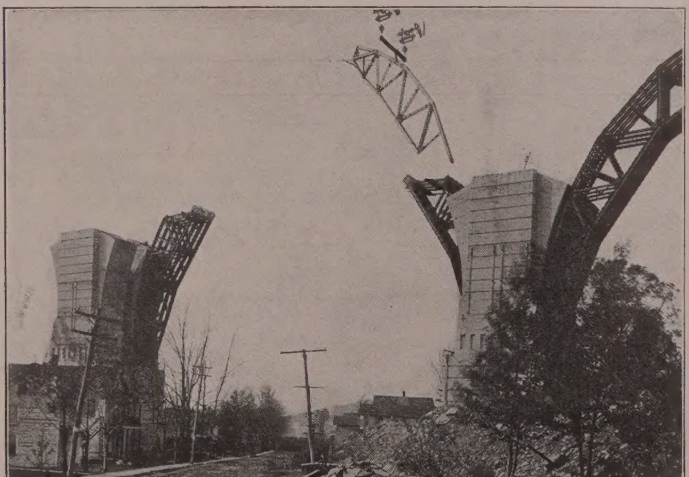
The concrete was deposited without forms to a height of 30 ft. above the rock foundations, and in many cases work was prosecuted continuously for several ten-hour shifts up to a maximum of about forty-eight hours. Concrete was delivered from the two duplicate plants at opposite ends of the viaduct at a maximum rate of 1000 cu. yd. in one shift. During the month of June, 1912, there was established the maximum record output of 14,000 yd. of concrete hauled an average distance of 800 ft. More than 9000 yd. of it were placed in forms. All of it was handled by 2-yd. bottom-dump Lockwood buckets, transported by the cableways.

The contractors maintained a supply of about 12,000 yd. of broken stone and 6000 yd. of sand in storage heaps at the mixer plants and about 4000 bbl. of Nazareth Portland cement in the cement house. Nearly all of the cement has been used direct from cars without passing through the storage house. The average monthly service for this contract includes the receipt of from 600 to 800 carloads of aggregates and other materials.

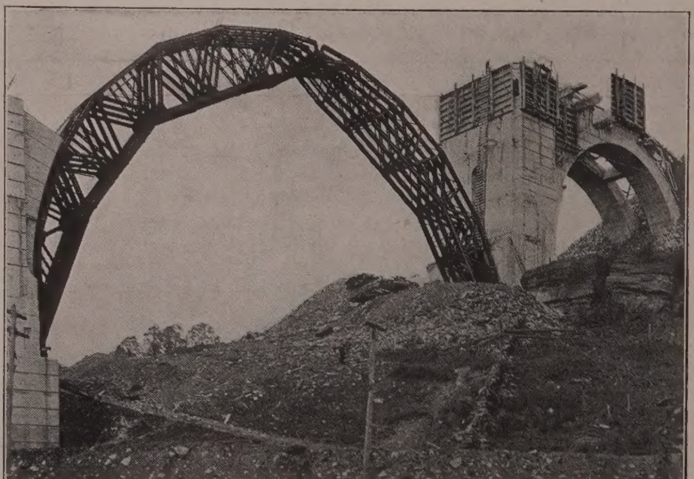
Pier Shafts

Above the surface of the ground each pier consists of a rectangular shaft to a point at the spring line of an arch. The concrete is deposited in wooden forms each side of which consists of panels 17 ft. 9 in. high. After four 4-ft. courses of concrete have been deposited in the form and have sufficiently set, the panels are disconnected and are separately moved up 16 ft. by the derricks or cableway and reconnected for repeated service. The heaviest panels weigh about 15 tons each. Four complete sets of regular pier forms were used.

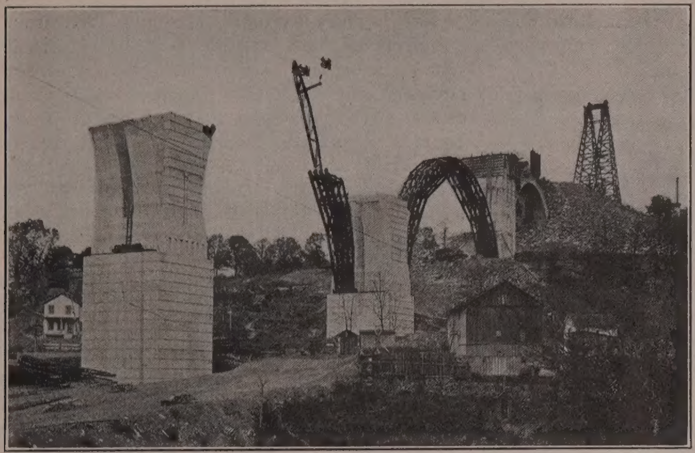
Concrete was delivered to the pier forms in bottom-dump Lockwood buckets, handled by the cableway and dumped while suspended from it by a special attachment devised by the contractor for dumping with cableway. The concrete was handled by derricks and was dumped by the derrick-engine operator. The tops of the piers project horizontally 4 ft. 3 in. beyond the intrados of the arch at a point 17½ ft. below the springing line, thus affording full-length tranverse seats at this



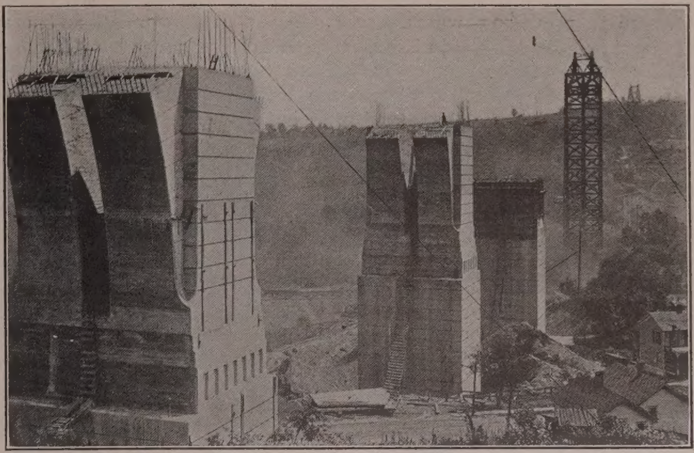
Erecting Second Section of Falsework Truss by Cableway



Set of Falsework Trusses for One Concrete Arch Rib



First Sections of Falsework Trusses Acting as Cantilevers



Umbrella Tops of Finished Piers Ready for Arch Construction

level, on which the arch centers are supported.

The concrete was carried up monolithic with the pier to a total height of about 35 ft. above the springing line, in special wooden forms overhanging both sides of the pier in an umbrella shape to receive the skewback constructon for the arches, projecting about 7 ft. beyond the springing lines. The upper surface of this concrete is smoothly finished on a radial plane with rectangular recesses to provide keys between the skewback concrete and the adjacent arch voussoirs. The completed pier shafts are very accurate, none of them being ¼ in. out of plumb.

Arch Center Loads and Stresses

The arch spans, for a length of about 166 ft. between the umbrella portions, are concreted in forms supported on steel centering carried by the piers without any intermediate falsework. Centering for one longitudinal half of the span is provided by the simultaneous erection of five sets of arch ribs and lagging and after concreting is completed on them the centering will be moved transversely 20 ft. on rollers to positions concentric with the second arch ribs. After these are concreted and sufficiently set the centering will be transferred to five other spans which will be built in the same manner.

The centering for each rib consists of four arch trusses, of 103 ft. 4 in. rise and 180 ft. span, in vertical planes 3 ft. 10 in. apart on centers, braced with top and bottom lateral angles and radial sway frames with bolted connections. The proportion carried by each semi-truss has an estimated weight of 631,000 lb. The weight of the steel work, lagging and forms is 54,000 lb., thus giving a vertical reaction at skewback pins of 685,000 lb., with a corresponding horizontal live-load stress of 242,200 lb. and a dead-load stress of 18,900 lb. The latter stress, when the trusses are moved laterally, is resisted by two horizontal rods 1 in. in diameter connected to the skewback pins.

The horizontal wind pressure for each semi-truss is resisted by two inclined anchor rods, 1½ in. in diameter, which pass through the umbrella-shape tops of the piers and engage the top chords of the trusses at points about 52 ft. above the feet of the trusses and by two 1¾-in. vertical anchor rods extending into the masonry bench support. The trusses are also guyed laterally in both directions at the quarter points and crown points by means of wire cables attached to ground anchors. The trusses are fabricated of medium structural steel, proportioned for unit stresses of 17,000 lb. for tension for net section and 17,000 — 70L/R compression for gross section. The top chord sections are also proportioned to take care of the bending stresses produced by the wet concrete.

The top chords of the trusses are made of two channels and a cover plate, and the bottom chords of two channels latticed. All of the web members are made of a pair of channels latticed or of a pair of angles, and the principal members were shipped riveted together so far as shipping clearances would allow. All of the field joints at panel points have bolted connections except at the skewbacks, crown, and two adjacent panel points on both sides of the crown, which are pin-connected.

The top and bottom chords converge to intersection on the crown hinge pin and the end sections of top chords support approximately horizontal pieces in the line of the adjacent top-chord sections to carry the lagging at the crown. These members, together with their supports at the crown and the end sections of the top chords, form triangular frames, with a clearance of about 2 ft. between them at the crown. This space is spanned by an oak block resting on bracket angles and supporting the lagging over the crown pins. Between the second main panel points above the skewback pins the top chords carry scarf planks curved parallel to the intrados of the arch on which the 4-in. lagging rests.

Adjusting and Striking Centers

In each panel at the crown the web member normal to the chords consists of two pieces connected by a right and left thread screw operated by a ratchet and lever so that the length of the member may easily be adjusted. This member forms the diagonal of a quadrilateral, with pin-connections at each vertex, and operates as a toggle to increase or diminish the length of the chords between skewbacks and crown and thus raise or lower the crown. U-bolts engaging the lower chord pins at the lower ends of the toggle panels support a working platform from which the ratchet levers are operated.

The skewback pins engage quadruple ped-

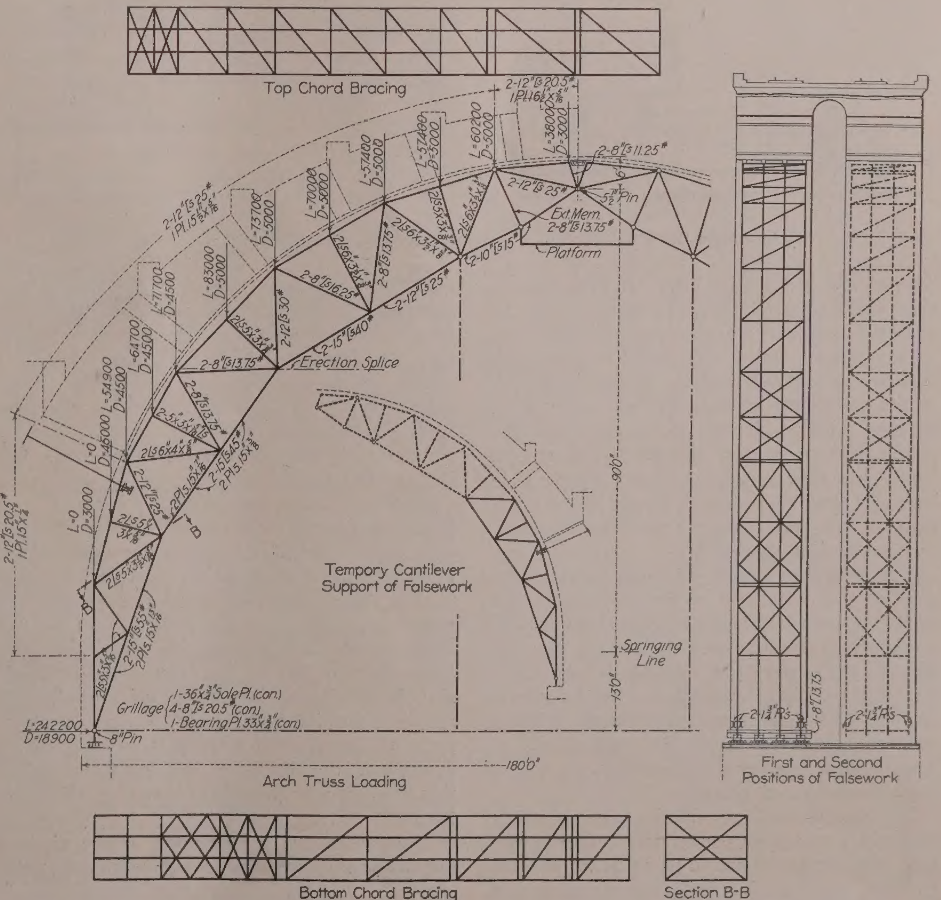
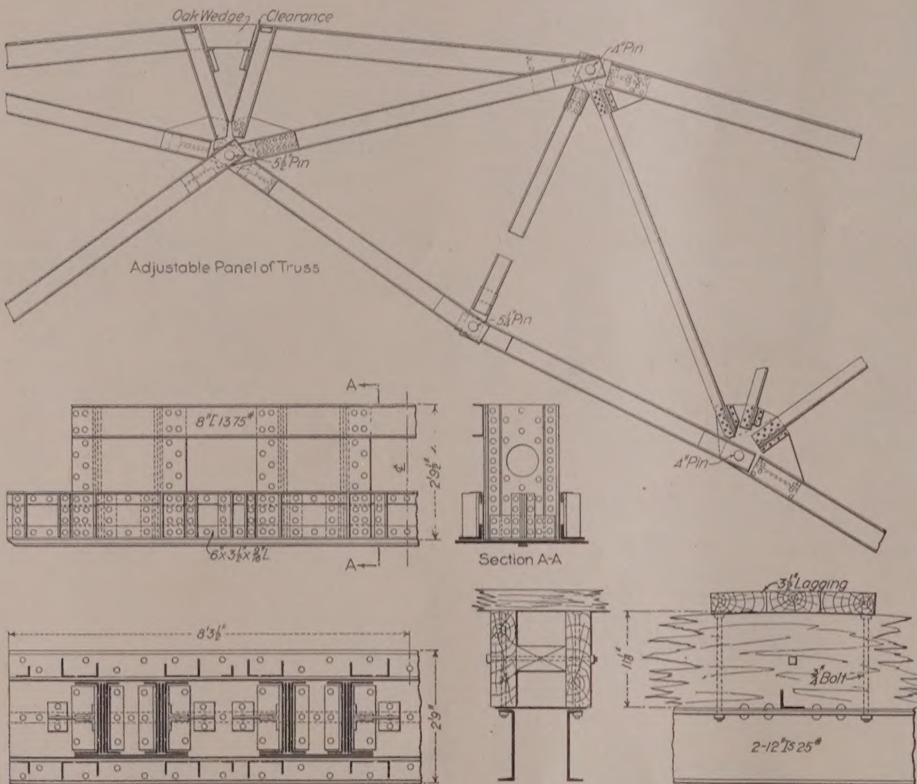


Diagram of Materials and Loading for Steel Falsework Trusses for 180-Foot Arch Spans estals 16 ft. 7 in. long, which serve as girder sills, spacing the trusses and supporting them when they are moved transversely from rib to rib. The base plate of the pedestal is 33 in. wide and 16 ft. 7 in. long, and is provided at the center-longitudinal line with a full-length 2½ x ½-in. guide rib, which engages the shoulders of a set of six 6-in. rollers placed under the center of each arch truss for the transverse movement. The rollers engage a corresponding guide strip on the center line of a bottom grillage 35½ ft. long which is seated on the top of the pier and consists of four 8-in. I-beams with full-length countersunk riveted top-and-bottom flange cover plates.

Each semi-truss is assembled in two nearly equal parts on the ground at the site, and the lower ends are successively hoisted by the cableway and their skewback pins are driven through the pedestals. They are supported by the cableway until they are anchored to the umbrella tops of the piers by pairs of temporary 1½-in. bolts with nuts at both ends, which pass through gaspipe sleeves embedded in the concrete and take bearing at the upper ends of washer plates. These bolts are perpendicular to the top chords of the trusses. The lower ends engage horizontal yoke beam bearing against the under side of the top chords, and thus maintain the truss segments in position like cantilevers.



Adjustable Crown Panel of Falsework Truss, Pedestal and Lagging

The second or upper segments of each truss were similarly erected by the cableway, which sustains them until their bolted connections are made to the first segments, when the completed semi-trusses are released by the cableway and remain in position as cantilevers fulcrumed on the skewback pins and held by the inclined bolts until the crown connections are made and the pairs of semi-trusses form complete three-hinged arches.

The strength of the inclined bolts and of the reinforced concrete in the umbrella portion of the piers is ample to resist all erection stresses, so that the semi-trusses require no extra supports from cableways, derricks or falsework. The operation of the inclined bolts raises and lowers the upper end of the semi-trusses, enabling them to be registered for the driving of the crown pins and are adjusted with sufficient clearance to eventually eliminate the cantilever action and leave the trusses to function solely as arches. These bolts with the base anchorage and guy cables have sufficient strength to provide for wind anchorage.

After the first rib of each arch is concreted the adjustable members in the crown panels of the semi-trusses are lengthened and the crown depressed enough to strike the centers and release the trusses, which are rolled 20 ft. transversely to a position concentric with the second rib of the arch, where the adjustable members are shortened to raise the crown and fit the lagging to the intrados of the rib. After the second rib of the span is completed the centering is rolled transversely into the space between the two ribs and the arch trusses are successively disconnected and the cableways remove their segments to the next span, where they are re-erected as already described.

The erection of the steel centers was commenced Sept. 23 and the center for the first arch rib, weighing 200 tons, was erected in eight days by the contractors' own force. On Oct. 15 the foundations for the Tunkhannock viaduct were about 80 per cent completed, and about the same percentage of the pier construction was finished. About 47 per cent ot the total amount of work on the viaduct was completed. Work was then in progress on the last two foundations, on four piers, and on the erection of steel centers for two spans. A total force of about 225 men was employed, and the work was in advance of the schedule required for its completion on contract time, June 15, 1915. All of the large and costly equipment installed for the construction of this viaduct was purchased new for this contract.

The design and construction of the viaduct are under the direction of the engineering department of the Delaware, Lackawanna & Western Railroad Company, of which Mr. G. J. Ray is chief engineer, Mr. F. L. Wheaton, engineer of construction for the Martin's Creek cut-off line; Mr. A. B. Cohen, concrete engineer, and Mr. C. W. Simpson, resident engineer in charge of the viaduct. The contract for the viaduct was awarded in June, 1912, to Flickwir & Bush, Inc., of which Mr. Frank M. Talbot is general manager and Mr. W. C. Ritner superintendent.

National-Aid Highway Bill

Congressman D. W. Shackleford, of Missouri, on Nov. 20 introduced in the House of Representatives a bill, No. 9333, providing that the Government shall in certain cases aid the States and the civil subdivisions thereof in the construction and maintenance of rural post roads. The measure carries an appropriation of $22,000,000, $2,000,000 of which would be paid on joint construction or maintenance by the State and Nation, the remainder, $20,000,000, to be paid for work in which the National Government will have no part, though the payment of the money would be contingent on certification by Government officials that the conditions—the maintenance of roads up to certain standards—had been fulfilled. Senator Hoke Smith, of Georgia, has introduced the same measure in the Senate.

The $2,000,000 to be spent by the Federal Government on work executed jointly with the State is to be apportioned as follows: One-third in the proportion which the total area of such State bears to the total area of all the States; one-third in the proportion which the total population of such State bears to the total population of all of the States; and one-third in the proportion which the total number of miles of rural post roads in such State bears to the total number of miles of rural post roads in all of the States. In no case shall the Federal Government bear more than one-third of the cost of construction or maintenance of any road.

For the appropriation of the remaining $20,000,000 the rural post roads will be divided into three classes. Class A includes macadam roads, or better; Class B, gravel roads; Class C, dirt roads. As to macadam and gravel roads, the specification is made that in order to be in the class, A or B, grades must not be steeper than is reasonably necessary, in view of the natural topography of the locality, and the road must be well drained, and constructed and maintained in such a manner that it shall have continuously a smooth, firm surface. Class C embraces dirt roads, "upon which no incline is steeper than is reasonably necessary in view of the natural topography of the locality, with ample side ditches, constructed so as to quickly shed water into the side ditches, and kept continuously crowned and compacted by dragging or other adequate means so that it shall have a smooth surface and be passable for wheeled vehicles at all times." For all roads coming in Class A the Government will contribute $60 per mile per annum; for roads in Class B, $30, and Class C, $15, provided the total allotted to any State does not exceed its apportionment, which shall be in the proportion which the total number of miles of rural post roads in such State bears to the total number of miles of rural post roads in all of the States. If the total of payments in any State shall aggregate more than the amount which may be expended in such State according to this apportionment, then such payments per mile shall be reduced pro rata till they shall aggregate said amount which may be so expended in said State, and no more.

Arnold Report on Chicago Railroad Terminals

Recommendations for Covered Tracks, Opening of New Streets, Better Use of Present Property and Better Interchange

CO-OPERATION, voluntary or compulsory, among the various railroads and the city of Chicago, entrances to the city in covered subways and the development and more efficient use of property already held for freight terminals are salient features in the latest report on the railway terminal situation in Chicago precipitated by the application of the Union Station Company for a permit to build a new passenger station on the present site and bring in another north-south freight terminal barrier on the west side. The report is by Mr. Bion J. Arnold, who prepared it for the Citizens' Terminal Plan Committee—an organization of representative business men and prominent citizens who subscribed $25,000 for a comprehensive report, feeling that no permission should be granted the Union Station Company until a complete analysis had been made of the whole railroad-terminal problem. Mr. Arnold studied all the previous reports and was furnished with data by twenty-eight of the railroads entering the city. Mr. John F. Wallace presented a report, reviewed on page 486 of the Engineering Record for Nov. 1, on the ordinance carrying the Union Station permit. His recommendations are fully discussed by Mr. Arnold, who, in the light of the comprehensive study, concurs conditionally with the passenger terminal recommendations, but not with those relating to the freight situation. The city council railway terminal committee, to whom Mr. Arnold's report was transmitted on Nov. 18 by the citizens' committee, has asked Mr. Wallace and Mr. Arnold to sit with them in their further deliberations.

Fundamental Recommendations

As a result of Mr. Arnold's study he states that he is convinced that Chicago should grant no further ordinances to steam railroads or other railway companies seeking to rebuild their present terminal facilities or to construct new terminals unless the ordinances contain definite provisions making the following fundamentals mandatory upon the road or roads benefited by the ordinance:

An agreement to co-operate with the other railroads affected, and with the city, in straightening the South Branch of the Chicago River.

The placing in covered subways beneath the street level, within a definite time, of all tracks of the steam railroads within the district bounded by Twelfth, Halstead, Lake Street and the lakefront (except the elevated tracks of the new Chicago & North Western Station and such tracks as are now or may hereafter be located within the present depressed area between Canal Street and the Chicago River; also the tracks of the Illinois Central Railroad along the lake front).

An agreement to co-operate with other railroads and the city in working out a plan which will ultimately open practically all of the north-and-south streets between State and Canal Streets, and practically all of the through east-and-west streets between Randolph and Harrison Streets, and also Polk, Taylor, Twelfth, Fourteenth and Sixteenth Streets, which are now blocked by railroad property.

The concentration of long-distance passenger traffic into the fewest number of terminals practicable, and at such locations as will offer the least obstruction to the extension of the business district consistent with reasonable accessibility therefrom.

An agreement to co-operate with the other steam railways and the city in the development to its fullest extent, along the most efficient modern lines, of the property now owned by various railroad companies within, or contiguous to, the business district of the city, with the ultimate object of the complete development of such property, so that the property now occupied by the companies in the business district between State Street and the river can be vacated and devoted exclusively to business purposes or the surface released by placing the tracks under ground and developing the property above the surface for business purposes.

Where streets or alleys are closed, temporarily or for long periods, an equivalent area or value to be given in return by the railroad in widening other streets.

The city to reserve control over all sub-sidewalk and sub-pavement space, not specifically vacated in the ordinance, that may be required for suburban transportation systems or other public utilities.

An agreement to co-operate with the city in the establishment of elevated thoroughfares across the railway property lying between Canal Street and the South Branch of the river, and westward as later may be deemed necessary. This system to be co-ordinated with the bridge levels established by the city and with the necessary changes in north-and-south thoroughfares to equalize the grades so as to facilitate vehicle traffic. The ordinance to provide means for ascertaining and finally to stipulate the division of cost of such changes proportional to the relative benefits derived by the city and the companies respectively.

Provision for a marginal way or river road contiguous to the river, extending along the railroad property west of the river between Lake and Sixteenth Streets, and the development of suitable docking facilities, municipal or otherwise, along the entire way, and underneath the bridge approaches where practicable.

Provision in all passenger stations hereafter constructed for through-connected or interchange tracks, so as to permit interchange of suburban service between roads operating in different parts of the city.

An agreement to co-operate with other roads to interchange the use of coach-yard facilities if necessary to carry out the through-routing or interchange principle for suburban service.

Commitment to the effect that the company will co-operate with the other roads in the working out of a general plan whereby the roads may be systematically grouped and brought into two or more terminal stations with the least amount of track occupancy.

An agreement to co-operate with other railroads and the city in establishing universal facilities at Clearing, or some other point, by means of which package freight (less than carload lots) now interchanged in the downtown district will be interchanged at such clearing point, thus preventing haulage of freight into the business center and back again as is done at present—the effect of which change would be to release present downtown freight facilities for the legitimate use of freight destined to and from the business district.

The removal of obstructions due to railroad occupancy which decrease the width of the river channel as now established, so as to permit the construction of bridges without encroaching upon the river channel.

Pennsylvania Terminals

The granting of an ordinance to the Pennsylvania Company for a passenger terminal, Mr. Arnold finds, need not be conditioned upon the granting of an ordinance to the same company for the use of the proposed freight terminal, for it is not evident that the company would need this additional territory for freight purposes for many years to come, if the roads owning the property between Canal Street and the river would co-operate in developing it to its fullest extent.

By means of double-decking Canal Street the property on the west side of Canal Street would be made available for terminal purposes, and there is no reason why this property should not be used for freight purposes if, after analysis, more space is found ultimately to be needed—provided the tracks are kept underground and the property developed overhead for business or manufacturing purposes.

How far these recommendations are enforceable through the Interstate Commerce Commission or the State Public Utilities Commission should be a subject for further study, but Chicago should now avail herself of the opportunity to regain control of her traffic districts.

Inasmuch as the Chicago Plan Commission has been established, has done such extensive and commendable work for the betterment of Chicago, and has been recognized by having certain of its recommendations carried out, such as the widening of Michigan Avenue and Twelfth Street, and the development of the present Lake Front Park, the city authorities should still further see that no structure is reared by any railroad company which will prevent the ultimate realization of such parts of the original plan laid down by Mr. Burnham as have met with the official approval of the Chicago Plan Commission.

Co-operative Plan

The easiest thing for the city to do, according to Mr. Arnold, is to require nothing and let the railroads have what they ask; the most difficult thing is to require the railroads to carry out the plan best suited to the entire city at their own expense; the just thing is to join with the roads in carrying out, on some equitable basis, a plan which will gradually put into effect such recommendations in this report and those of Mr. Wallace as are considered sound.

With reference to the magnitude of this problem and the enormous costs and difficulties involved, not only to the railroad companies but also to the city, in the rearrangement of the properties in accordance with the suggestions made, Mr. Arnold states that he does not wish to be understood as counselling any one-sided policy of compulsion on the part of the city for the carrying out of any of the suggestions.

The general method of street improvement and the extension of the business district recommended by Mr. Wallace is concurred in by Mr. Arnold, but the retention of the Pennsylvania freight site is not concurred in, nor the unconditional retention of the passenger terminal site at Adams Street; and, in fact, another site is recommended as preferable. Neither is the premise accepted that present divisional occupancy and operation of railroad properties must govern their ultimate disposition in meeting the necessities of terminal reorganization recommended.

Collapse of Seven-Story Stark-Lyman Concrete Building at Cedar Rapids

What Happened and Some of the Opinions Advanced to Account for the Failure of the Structure

FINAL conclusions regarding the cause of the failure at Cedar Rapids, Iowa, of the Stark-Lyman seven-story reinforced concrete building, about one-third of which collapsed on the afternoon of Friday, Nov. 14, while the roof was being poured, must be deferred until the results of the official investigation of the accident are made public. The principal facts in the case were reported in the Current News Section of the Engineering Record last week.

Dimensions of Building

The building is 60 ft. wide, 140 ft. long and seven stories high. It is divided into bays about 20 ft. wide by beams spanning the width and resting on two lines of columns, making spans of 20 ft., center to center. The floors are combination tile and concrete, the ribs being 4 ft. wide. The accompanying drawing shows a typical floor plan of the structure.

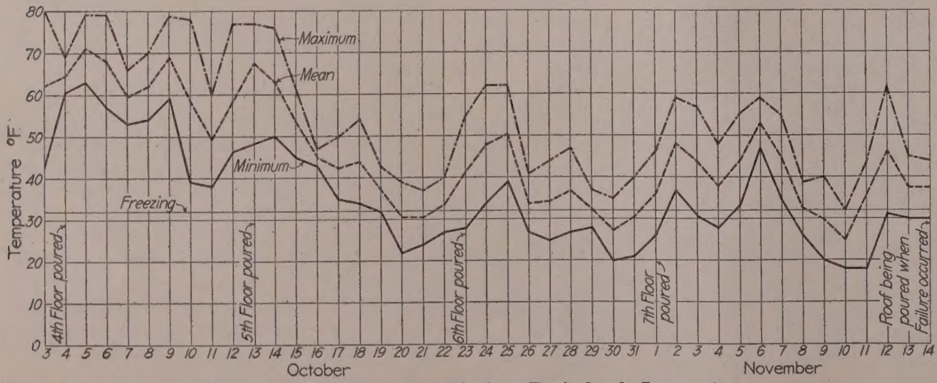
The heights of floors of the building were as follows: Basement to top of first floor, 11 ft. 6 in.; first to second floor, 17 ft. 2 in.; second to third floor, 13 ft. 8 in.; third to fourth, fourth to fifth, fifth to sixth and sixth to seventh floors, 12 ft. 8 in.; seventh floor to roof, 13 ft. 6 in.; total height of building, 106 ft. 6 in.

The fourth floor was poured Oct. 4; the fifth floor, Oct. 13; the sixth floor, Oct. 23; the seventh floor, Nov. 1. The roof was being poured on Nov. 14 and part of the first bay on the rear end was in place when the accident occurred. Three sets of forms were used, so that forms and supports were in place under the sixth and seventh floors only when the roof was started. Props were in place under the beams on the fourth and fifth floors, but no supports were under the floor slabs.

The parts now standing seem to have been uninjured and the workmanship is apparently good.

Personnel

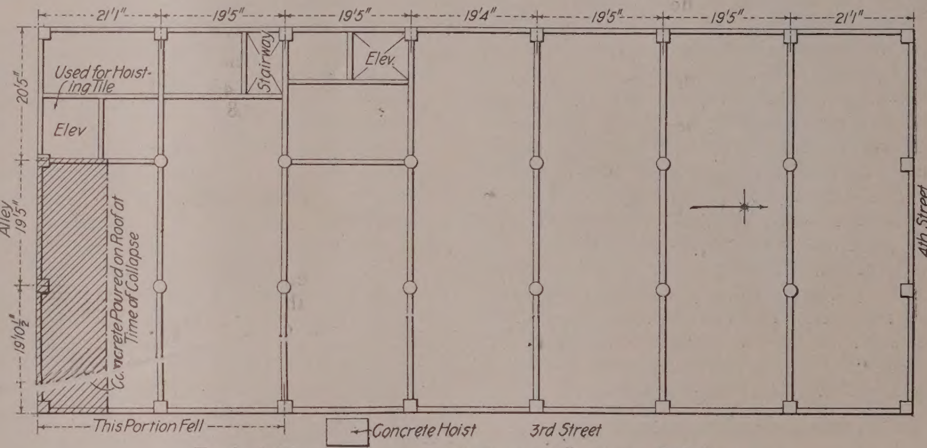
The contractor for the building is the Lauritzen & Wasson Corporation, of Waterloo, Iowa. The owners furnished the steel reinforcement. Mr. H. J. Bishop was superintending engineer for the owners. The drawings were made by Maybery & Company, architects, of Cedar Rapids, and the reinforced concrete design was prepared by William B. Hough & Company, of Chicago, who furnished the steel reinforcement. The plans were checked by Mr. Ernest McCullough, consulting engineer, of Chicago.



Ranges of Temperature during Period of Concreting

Two eye-witnesses of the accident are said to have observed the column between the fourth and fifth floors bulge out about the level of the fifth floor and then fall inwards.

Two other eye-witnesses claim to have seen the top columns under the roof lean out and the concrete pour over the edge, while the men on top, on their knees, clung to the edge until they thought it would drop into the alley, when suddenly some force seemed to pull them backward into the building. A number of engineers who have examined the site seem to think that these reports are consistent. The time was of course short and not all the eye-witnesses were able to take in all that was happening at all places on the wall, so their reports must be patched together. One engineer expressed the belief that the fifth floor columns gave way first, but he had heard the stories of only the first eye-witnesses.



Typical Floor Plan of Stark-Lyman Concrete Building

Opinions on Failure

That the failure occurred on the fifth floor seems to be the consensus of opinion among engineers who visited the wrecked structure. After the column was released and swung out the conjecture is that the rods in the sixth floor held the sixth floor column from going out for an instant, but the top end of the column under the roof had nothing to hold it and as the freshly poured concrete was at the edge of the roof these columns naturally swung out. That they did not go clear over into the alley is due, possibly, to the fact that the sixth and seventh floors gave way before the center of gravity of the load on the columns under the roof had swung outside the wall, so the roof columns were suddenly jerked back into the funnel.

Another reason has been advanced for believing that the failure occurred on the fifth floor. The engineer for the owners, it is reported, thought that three sets of forms were sufficient. Therefore, the centers had been drawn from under the fifth floor to be used under the roof, the seventh floor carrying the roof, the sixth floor the seventh floor and roof, and the fifth floor the sixth and seventh floors and the roof. Assuming that the concrete on the sixth and seventh floors was so green that it could not be trusted to carry its own weight, the conclusion is that the fifth floor was carrying all the load.

The floor was of combination tile and concrete, the ribs being 4 in. thick. The centers supporting the forms were spaced approximately 4 ft. apart. They were designed by the engineer for the owners, Mr. Bishop, who is said to have objected to the forms and centering used on the first floor by the contractors. Instead of laying wide planks across the floor to distribute the load from the posts reports from Cedar Rapids state that the posts rested on blocks 6 and 8 in. wide and from 18 in. to 24 in. long. This being the case, there were concentrated loads on the fifth floor of over 1 ton, spaced at approximately 4-ft. intervals.

The accompanying diagram shows the temperatures while the concrete work was in progress.

Cutting Up Débris

A representative of the Oxweld Acetylene Company, of Chicago, was in Cedar Rapids when the building fell and he at once telegraphed to his company to send an apparatus up with a skilled operator. This was done and at 3.30 a. m. Saturday the flame was at work giving a demonstration, which lasted five minutes. The city officials immediately closed a contract at $3.50 per hour for the outfit. If such an outfit had not been at hand to cut up the wreckage the rescue work would have taken much longer.

The bodies of the foreman and one laborer were recovered Saturday morning. Two more bodies were found on Sunday afternoon. The superintendent of construction was found on Monday afternoon and the body of another laborer on Tuesday. A seventh man died in the hospital, where three men still remain suffering from severe injuries.

The head carpenter was on the seventh floor watching the roof forms when he felt the floor giving way and rushed to the front of the building, barely reaching a solid floor and clasping a post as the rear portion of the building collapsed. He saw his boss and the other men swept away. A negro on the floor with him was killed.

On the sixth floor two negroes were watching the forms and centers. One was killed and one escaped and is in the hospital. He said he felt the floor sinking and jumped to the vacant lot 80 ft. below.

The form-watcher on the fifth floor was killed. It is reported that one negro leaped from the roof to the street and a large piece of form panel blown out from the fifth or sixth floor broke his fall, thus escaping serious injury.

One story says he "volplaned" to the street on the form. That he was on the roof is not disputed and that he leaped to the street is known by those who saw him. That his fall was broken by a piece of form seems to be pretty well proved by eye-witnesses. The roof is 106 ft. above the street level.

Flood-Protection Plans for Ohio Cities

Abstract of a Report by John W. Hill, Consulting Engineer, of Cincinnati, Recommending Changes in Course of Miami River at Hamilton and Middletown

PLANS for the flood protection of Hamilton and Middletown, Ohio, based upon a survey and study of the Miami River, were filed with the Emergency Commission of Butler County on Nov. 17 by Mr. John W. Hill, consulting engineer, of Cincinnati. No action will be taken until every effort has been made to secure co-operation of counties to the north in a general flood-prevention scheme.

Mr. Hill suggests two plans for protecting Hamilton, one for protecting Middletown, and two for protecting the entire county, including these two cities. Each plan embraces widening, deepening and straightening of the channel, and the construction of levees.

The cost of the work, including the protection of Hamilton and Middletown, is estimated at $12,250,000. The cost of protecting Hamilton alone is estimated at $3,806,175, which does not include the amount which would have to be paid for property on either side of the Miami River which must be condemned. The cost of protecting Middletown alone is estimated at $3,855,430.

Plans for Hamilton

In addition to the one general scheme for protecting the county, Mr. Hill has two plans for protecting Hamilton. Both of these plans demand that a concrete retaining wall be constructed on each side of the river from Black Street to Sycamore Street, making the channel 650 ft. wide and 35 ft. deep. This would require the construction of 14,340 lin. ft. of retaining wall at a cost of $645,300; 6500 ft. of converging and diverging walls at a cost of $292,500, and contingencies, such as engineering, supervision, etc., amounting to $464,670. The present channel has a width of about 435 ft.

In plan 1 for protecting the city Mr. Hill proceeds on the theory that the channel will be allowed to remain in its present location. This would entail 18,000,000 cu. yd. of dredging and excavation costing $2,160,000 and the purchase or condemnation of 1383 acres of land above Black Street and below Sycamore Street at a cost of $138,300. The total cost of this plan exclusive of the bridges is $3,700,700.

Plan 2

Plan 2, for protecting Hamilton, proceeds on the theory that the channel of the river will be straightened above Hamilton, that the cut off will be from a point 1500 ft. above the upper dam of the Hamilton & Rossville Hydraulic Company to the mouth of Old River above Black Street bridge. This will require 21,160,000 cu. yd. of dredging, to cost $2,539,200, and means the taking of 1440 acres of land at a cost of $144,000, and contingent expenses amounting to $477,575, or a total cost, exclusive of the bridges, of $3,806,175.

All excavation and dredging is figured to cost 12 cents per cubic yard.

Comparison of Plans

If plan 1 is adopted a flood of the volume of March, 1913, would not be any higher than the flood of 1898, and would do no damage, and if plan 2 is adopted, a flood as big as that of 1913 would be 2 ft. higher than that of 1898 and would do no damage. Any plan adopted would mean that a flood of the size of last March will be 4½ ft. lower at High Street than that of 1898.

The first plan also provides that the work begin 3900 ft. below the upper Hamilton and Rossville dam and continue for a distance of 34,780 lin. ft. to a point 10,100 ft. below the old Columbia bridge. Levees along the east bank of the River would protect Peck's Addition from destructive floods.

The cutoff in the second plan would entail the construction of another railroad bridge below the present New River structure, which would have to be from 1321 to 3300 ft. long. The present Hamilton & Rossville Hydraulic Company's dam would have to go, but this condition could be remedied by the construction of a dam further up the river.

The concrete channel walls from Black Street to Sycamore Street would be 35 ft. high, with a cutoff wall under the inner toe of the base 3 ft. wide and 10 ft. deep. This channel is sufficient for a flood of last March, with a 25 per cent margin for a greater flood. The channel would be self-scouring.

The land required for the construction of this channel would be 4660 ft. long and 147 ft. wide on the west side and 4660 ft. long and 138 ft. wide on the east side. These figures are not exact, because in some places the channel at present is wider than at other points.

The line drawn for the concrete channel through Hamilton runs through the center of the monument, 70 ft. from the east bank of the present channel, and if the plan is finally adopted it will necessitate the removal of the monument and the condemnation of all the property on the east side of the river back to Monument Avenue between Sycamore and Buckeye Streets and nearly to Second Street from Buckeye Street to Black Street. On the west side of the river the plan contemplates the condemnation of all the property to within about 50 ft. of B Street from Black Street to Arch Street and the new city hall site on the east side of the river.

No one has figured what it would cost to take this property, but it would include the condemnation of the east mill of the Champion and all of the valuable property between A and B Streets on Main Street.

If this step is ever taken it is likely that all of the property back to B Street would be condemned and that not needed for the channel converted into a park.

A rough estimate on this property places its value at $1,000,000.

Protecting the County

Mr. Hill has two plans for the entire county. The only difference in the plans is that one calls for seven cutoffs in the channel throughout the county, reducing the length of the stream 6.6 miles, and the other calls for only one cutoff above Middletown and a short distance below the State dam where the channel forms a U.

The first plan would mean the excavation and dredging of 125,500,000 cu. yd., of which about 35,000,000 would be used in levees 248,500 ft. in length, and the remainder would be used in filling old channels and wasted behind the levees.

With only one cutoff 136,650,000 cu. yd. of dirt would have to be dredged and excavated, of which 42,700,000 would be used in the construction of levees of a length of 304,900 ft. and the remainder used in filling the old channel and wasted behind the levees.

To follow either of these plans would cost at least $12,250,000, according to estimates of contractors. But this, of course, would include the cost of the concrete retaining walls through Hamilton.

This work is so stupendous as to make the cost of either plan prohibitive, and it is therefore suggested that the farmlands be left unprotected, except for what benefit they will receive from the Hamilton and Middletown improvements. To protect the farmlands would require 77,580,000 cu. yd. of dredging and excavating at a cost of $9,309,600, with contingent expenses of $930,960, making a total cost of $10,240,560. The damage to 10,000 acres of farmlands in Butler County by the last flood Mr. Hill estimated at $1,000,000.

For the protection of Middletown alone Mr. Hill's plan contemplates the dredging, widening and deepening of the channel from the Warren County line to the Ohio Electric Railway bridge below Middletown, a distance of 7160 ft. below Third Street. It contemplates the construction of a bridge of three 405-ft. spans over the river at that city, the condemnation of 1614 acres of land valued at $161,400; 26,760,000 cu. yd. of dredging at a cost of $3,212,200, and contingent expenses amounting to $491,830, or a total cost of $3,855,430.

Size of Levees

Wherever levees are constructed they will be of an average height of 25 ft. and will be 100 ft. wide, with extra dirt wasted behind them.

The report also gives the width of the river at various points along the stream, ranging from 1107 ft. at Middletown to 1717 from Sycamore Street, Hamilton, to Pleasant Run, except for the channel between Black Street and Sycamore Street, Hamilton, which will be 650 ft. wide. The depth of the entire channel is from 26 to 28 ft.

The capacity of the new channel will be 27 per cent in excess of the flow of last March.

The drainage area of the Miami is 5342 square miles. The river length is 143 miles, of which 115 miles are above Hamilton. The stream flow at the crest of the flood of last March was 318,771 sec-ft.; in 1898 it was 110,000 sec.-ft. Water will flow through the improved channel rapidly, but there will be no danger of dame from erosion. Movable dams should be constructed, patterned after the Government dams in the Ohio. The Hamilton & Rossville Hydraulic Company's dams above the city are a menace, according to Mr. Hill's report.

Scow for Submarine-Rock Drilling

Hull Equipped with Steel Spuds and Four Traveling Drill Columns Having 28½-Foot Vertical Hydraulic Drill Movements

IMPROVEMENTS of the East River, New York City, now in progress include the deepening of the channel between North and South Brothers Islands to a depth of 26 ft. below low-water level. This is accomplished by the removal of 2 to 6 ft. of sand and clay and about 14,000 cu. yd. of rock having an average thickness of 3 ft. The rock is drilled from a boat, is blasted with dynamite and removed by dredging. The excavating plant is exposed to a tidal current averaging 6 miles per hour, and is designed for excavating to a maximum depth of 60 ft. The construction of the boat and the equipment conform in general to standard practice; the special arrangement and a number of improved details are adapted to the rapid and convenient execution of heavy work.

Drill Boat

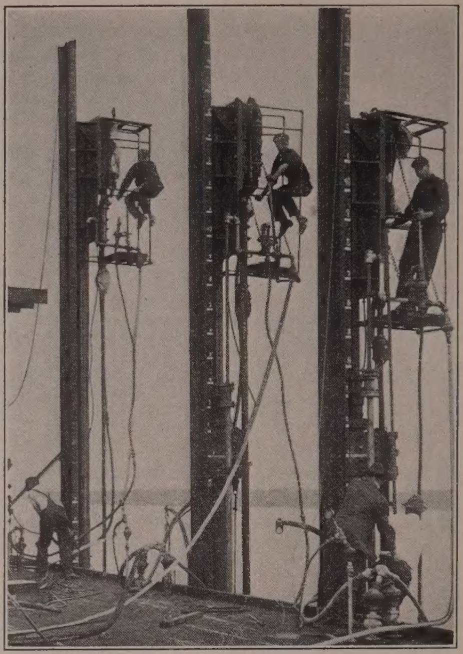
The drilling apparatus, which is capable of putting down simultaneously, at any stage of the tide, four 3¼-in. holes, 5 ft. or more apart in any position on a line 60 ft. long, is installed on the deck of a 32 x 110-ft. scow 12 ft. deep. The crew of 20 men have bunks on a mess boat anchored near by, and three small berth rooms are provided for the convenience of the watchman and assistant.

The boat is secured in working position by four steel spuds, each raised and lowered by a 1⅛-in. steel cable operated by separate 7 x 10-in. Flory hoisting engines. Adjacent to these engines are four 5 x 8-in. engines for operating the mooring lines, which are led between roller chocks. Below deck are two engines, each operating a horizontal shaft above deck geared at each end to a drum and two capstan heads, used for raising the drill columns and for moving them back and forth on their trolley track. At each end of the hull there is a steam capstan for operating a manœuvering line.

A horizontal one-rail track, 60 ft. long, extends close to one side of the boat and carries four trolley carriages supporting the steel-pointed drill columns, which rest firmly on the river bottom and hold the drills securely in place while holes are being put down and charged. Each column carries a long vertical hydraulic cylinder with a drilling machine attached to the upper end of its ram and a platform for the operator.

The drill bit works in telescopic tubes that remain in position after the drill is withdrawn and until the hole is charged full depth with 75 per cent dynamite. Cartridges 2 in. in diameter are placed in a tin tube inserted in the hole by a loading gun composed of a slotted pipe and wooden rammer. The columns are then raised clear of the bottom and moved on the trolley rail to new positions 5 ft. or more distant. After the completion of a row of holes the boat is moved about 50 ft. and the charges fired. The blasted rock and overlying material are removed by a dipper dredge and carried to sea in bottom-dump scows. Under favorable conditions the capacity of the boat, with a crew of 20 men working two eight-hour shifts, is about 2000 cu. yd. of rock per month.

The boat is equipped with two 7 x 12-in. outside packed plunger pressure pumps and two 4 x 10-in. wash-water pumps, all of Davison make.



Drilling Machines on Adjustable Columns

There is a 250-hp Scotch marine boiler, for which 6000 gal. of fresh water are carried in three steel tanks. A bunker on the main deck holds a coal supply of 45 tons.

Steel Spuds

The spuds are located about 15 ft. from the ends of the hull and move vertically between 10 x 20-in. guide timbers 26 ft. long. Each spud is 46 ft. long and weighs 14,000 lb. It is substantially a Gray column made of four pairs of main angles and four single corner angles connected by tie plates having on one side continuous short sections, with their corners cut off to provide entrance for holding on rivet heads from the inside of the columns. The lower end has a pointed cast-steel shoe intended to penetrate the surface of the rock and keep the spuds in position. Single sheaves fixed to the upper and lower ends of the spuds are rove with endless 1⅛-in. steel cables operated by a hoisting engine, which raises or lowers the spuds or transfers the weight of the boat to them.

Drill Columns

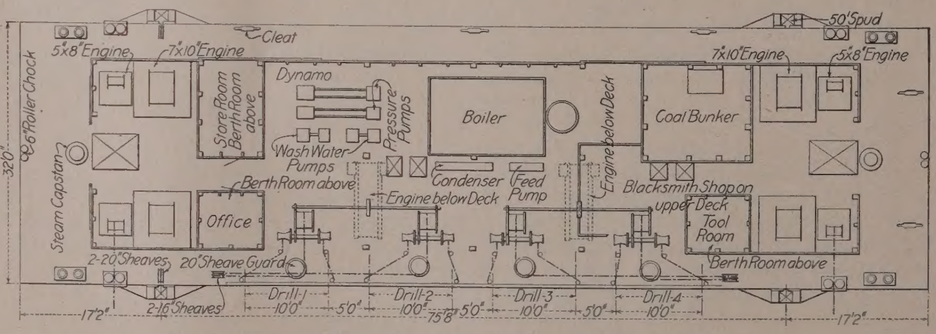
The drill column, 71 ft. long, weighs 18,000 lb. and has a full-length, 15-in., 40-lb. vertical channel, reinforced by two full-length 3 x 3-in. angles riveted to the inner face of the web. There are also, riveted to its flanges, two full-length 3 x 3-in. angles, with their outstanding legs engaging guide slots in the trolley carriage by which it is supported. The column is raised and lowered to correspond with depth of water and stage of tide.

Bracketed to the back of the column channel is a vertical hydraulic cylinder seated on the column shoe. The cylinder has an 8-in. ram with a 28½-ft. stroke and carries at the top the drilling machine and the operator's platform and cage. The operator controls both the ram and the drilling machine.

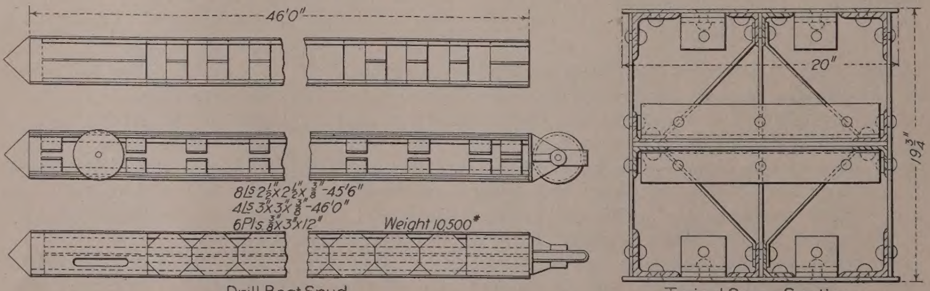
A 6-in. vertical steel pipe 12 ft. long is bracketed to the foot of the column channel outside the hydraulic cylinder, with the reinforced lower end resting on the bottom. A telescopic 5-in. pipe 20 ft. long works up and down inside the 6-in. pipe. The top of the 5-in. pipe is always maintained above water level and the two pipes form a guide within which the drill steel works, and which also serves as a casing to exclude mud and sand and to insure the insertion of the dynamite charge in the drill holes. Both pipes are slotted to clear the electric wires of the cartridge exploders.

Drilling Machines

The four duplicate drilling machines were designed especially for this work by the McKiernan-Terry Drill Company. They are of their regular Corliss valve type, having cylinders 7 in. in diameter and a stroke of 10 in. They differ materially from other tappet drills in that they have a cylindrical valve placed parallel with the bore and having a very free and quick action. The valve is practically a balance valve and therefore places very little weight upon the piston and tappets. The tappets are so set in the cylinder as to have a sliding motion upon the piston;



Arrangement of Plant Installed on Main Deck of Drill Boat



Drill Boat Spud

Typical Cross Section

Structural-Steel Anchorage Spuds with Solid Cast Point this imparts an oscillating motion to the valve.

The valve is made with three members, the end members being interchangeable, and has a simple member upon which the tappet acts, connecting the two end members and imparting motion to them. At the point of contact between the bore and tappet the central member has a curved surface, so that at the beginning of motion the tappet has the greatest leverage over the action of the valve, this motion gradually increasing until the end of oscillation. With this mode of valve action it is possible to have much shorter valve movement and also much shorter ports from the valve to either end of the cylinder, thus giving a much shorter passage. The action of the valve being quick gives a very free inlet and exhaust from the cylinder.

One of the special features of this drill is the lengthening out of the piston rod to allow the use of a wash-water chamber around the rod. The piston rod has a longitudinal hole drilled up to and connecting by transverse holes with the water chamber. The water, supplied to this chamber under a pressure of 50 to 150 lb. passes through the transverse holes into the central hole, and thus down through the hollow drill rods to wash the cuttings and sludge from the drill hole.

The drills are provided with steels 50 ft. long, including a 45-ft. shank made of cold-drawn seamless-steel tubing 2½ in. outside diameter with ¾-in. walls. The six-point rose bits are made of imported hexagon hollow drill steel 2½ in. in diameter. They are made in regular lengths of 15 ft. and are pierced full length with holes ½ in. in diameter, through which the wash water is constantly forced to clean out the rock hole. They are connected at the shank with a special heavy coupling secured by automatic wedge clamps, and may be quickly set and released. The drills are stated to be very rapid and satisfactory. On this work they make from 250 to 275 strokes per minute.

The work is being done under the direction of the U. S. War Department, Col. W. M. Black, Corps of Engineers, in charge. The Michael J. Dady Engineering & Contracting Company, Brooklyn, N. Y., is executing the work for Mr. T. J. Dady, contractor. The drill boat was designed and its equipment installed under the direction of Mr. Austin T. Byrne, consulting engineer.

Conserving Macadam Surfaces

Conserving macadam surfaces, the maintenance of which motor traffic was making prohibitive, is being effected in Allegheny County, Pennsylvania, by using them as the base for new brick or asphaltic-concrete roads. Mr. J. S. Gillespie, county road commissioner, in addressing the American Road Congress at Detroit, stated that for brick roads the macadam is first scarified and formed to a true cross-section, concrete curbs are built, the sand cushion is placed and the brick are laid, after which the surface is grouted with a mixture of equal parts of sand and cement. In the other class of construction, bituminous concrete is laid directly upon the scarified and leveled surface, of course, and both finished surfaces are rolled. The method is said to be economical and satisfactory.

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The Steel Columns which are to be tested on the new Emery machine at the Bureau of Standards, Washington, have been fabricated and are ready for shipment. The work will be done in connection with the special committee on steel columns and struts of the American Society of Civil Engineers.

Recommendations Adopted by Conservation Congress

Regulations for Protecting the Rights of the Public, the Government and Investors

As noted in the Current News Section of this journal last week, the Fifth National Conservation Congress on Nov. 19 adopted the unanimous recommendations of the water-power committee. Majority and minority reports were also offered, differing only in detail from the recommendations. The action of the congress, of course, brushed aside both reports. The members of the water-power committee were: George F. Swain, president of the American Society of Civil Engineers, chairman; Gifford Pinchot, former chief forester; Henry L. Stimson, former Secretary of War; Lewis B. Stillwell, consulting engineer, New York; Charles R. Van Hise, president of the University of Wisconsin; M. O. Leighton, former chief hydrographer of the U. S. Geological Survey; E. S. Webster, of Stone & Webster, Boston; B. M. Hall, consulting engineer, Atlanta, Ga.; Joseph N. Teal, of Portland, Ore., and A. F. Lever, congressman from South Carolina. All of the members except the last two signed the "unanimous recommendations." Those who signed the majority report were Messrs. Swain, Stillwell, Leighton, Webster and Hall, while Messrs. Pinchot, Stimson and Teal signed the minority report.

Because of the importance of the action of the congress, which is emphasized in an editorial elsewhere in this issue, the adopted recommendations are given here in full, while comments of some of the members of the committee and of Mr. Arthur Williams, of New York, are added. The recommendations are as follows:

The Committee on Water Power, while finding a difference of opinion among its members as to certain details of the subject, feels very strongly the importance of making clear the general principles which control it and realizes keenly the consequences which would follow a failure to agree upon a constructive program of progress. It has, therefore, framed the following brief statement of the recommendations upon which it is unanimous:

A grant of the right to use a water power, while differing in some details is essentially similar to a grant of any other privilege or franchise from the Government, State or National, and its terms, regulation and control should be guided by essentially the same principles necessary to safeguard the rights of the public and of posterity as have been found essential in the case of other classes of franchises from the Government. Particularly is this true in view of the fact that a water power being perpetual will surely tend to increase in value as other sources of power, such as coal and oil, become exhausted. At the same time, for the very purpose of preserving our other power resources which are capable of exhaustion, the development of water power, under proper safeguards of the public interest should be earnestly encouraged and hastened. We recommend that the following principles should govern the granting of a privilege to use a water power:

(a) For a definite period, sufficient to be financially attractive to investors, the privilege should be irrevocable except for cause, reviewable by the courts:

(b) Thereafter the privilege should continue subject to revocation in the absolute discretion of the Government exercised through its administrative board or officer upon giving reasonable notice and upon payment of the value of the physical property and improvements of the grantee as below provided under (h)

(c) After the expiration of the period provided for in (a) above, at recurring intervals of not more than ten years the amount of compensation to be paid to the Government for the privilege and all the terms and conditions of the grant during the next succeeding period of not more than ten years shall automatically come up for determination by the granting officer of the Government.

(d) The privilege shall be unassignable except with the approval of the Government in order to safeguard the interests of the Government against speculation in water powers and against appropriation without prompt development.

(e) The privilege shall be granted only on condition of development of the whole capacity of the power site as rapidly as the granting officer may from time to time require, giving due consideration to reasonable market demands and conditions and also on condition of continuous operation, subject to such demands and conditions.

(f) The right to receive compensation for the value of the privilege varying according to the proper conditions of each case shall be reserved to the Government, State or Federal, from whom the privilege comes. We believe that the reservation of such a right to compensation is a vital essential towards the end of proper regulation. It is not sufficient to trust that the public will always receive its proper share by means of regulation of rates alone. Local authorities may neglect or may be unable, under conflict of jurisdiction, or for other reasons, to exact in the interest of the public the full value of the public's right. The value of a water power may in the course of time increase far beyond the power of local regulation to adequately distribute its benefits. At the same time, the method of exacting compensation must be carefully safeguarded so that in case full compensation by rate regulation is exacted by local authorities, an additional burden shall not be imposed. We believe that in normal cases the best method is for the Government to share increasingly in the net profits of the enterprise, provided, those profits exceed a certain reasonable percentage, the right of the Government being recognized otherwise merely by the imposition of a small annual fee or its equivalent.

(g) The Government shall have the right to prescribe uniform methods of accounting for the grantee and to inspect its books and records.

(h) Upon revocation of a privilege by the Government the grantee shall be paid a compensation equivalent to the fair valuation of its property, exclusive of franchise and consequential damages; this compensation shall include such appurtenances as are necessary for the operation of the water power and the transmission of electricity therefrom but shall not include such properties as railroads, lighting systems, factories, etc., which are of themselves separate industries.

In such transfer all contracts for the sale or delivery of power made in good faith previous to such notice of transfer should be assumed by the transferee so that the said grantee may operate and maintain the power business during his occupancy of the property under such stable guarantees as may beget confidence therein by prospective long term contractors, provided, that the Government or said transferee shall not assume any contracts made at a price or under conditions which shall be determined by the proper administrative officer of the Government to be unreasonable or confiscatory.

Interviews

Commenting on the action of the Congress, Professor Swain said:

"If the action of the Conservation Congress regarding the merits of the water-power question can be disentangled from all political considerations, I think it will be found that some real progress was made. The Water-Power Committee, while it could not agree on a full report, was nevertheless able to agree unanimously on certain fundamental principles, which, if adopted, will much improve the present situation. The most important of these were:

"1. The recognition of the right of federal control.

"2. The abandonment of the revocable franchise now required by law, and the substitution of the *indeterminate franchise* having no fixed term.

"3. The adoption of the principle that the charge made by the government should be in the form of a division of the earnings above a defined percentage on the money properly invested.

"The essential difference between the majority and minority reports was that the majority believed that subject to the above conditions, and in view of the state regulation almost everywhere existing, there was nothing to be feared from a monopoly of water-power, but that the main emphasis should be placed upon *development* in order that the use of this resource, the utilization of which saves one of our non-renewable resources, should be encouraged to the utmost. The minority report, however, placed the main emphasis upon the prevention of monopoly.

"Let anyone read the two reports and the unanimous recommendations, and he will see this clearly. The real merits of this question have been obscured. Anyone who desires not to be misled should read the original papers.

"As chairman of the committee I wish to express my thanks to each and every member of the committee and my appreciation of their efforts to help in solving this problem. Such differences of opinion as existed have been no more than would be expected among honest-minded men all desirous of serving the public interest and advancing the cause of conservation."

Mr. Pinchot has summarized his views as follows for this journal: "The action of the Conservation Congress emphasizes the necessity of public regulation over water-power corporations. The congress asserted that compensation to the public is an essential part of proper regulation, pointed out the alarming increase in water-power monopoly, and declared for continued public ownership of public water-power sites. The chief significance of its action lay in the overwhelming defeat of 'States' rights' advocates, who injected that issue themselves and of water-power interests, who attempted to prevent a declaration against monopoly. The result will be to strengthen the advocates of development under public control, make it harder for reactionary interests to prevent legislation, fair to both sides and so will, in my judgment, tend directly and powerfully to a just settlement of the controversy and the increase of development, which is what we all want."

Mr. Stillwell believed that "The Congress had accomplished something that will be valuable in a constructive way. It has placed both sides on record. What is necessary now is to follow up the work of the Congress, to have the law providing revocable franchises repealed, and one embodying the adopted recommendations enacted."

Mr. Arthur Williams, general inspector of the New York Edison Company, and chairman of the public policy committee of the National Electric Light Association, who has followed the matter of water-power development closely, interpreted the action of the Congress as follows: "The action of the Congress is the first step in straightening out the inadequate and unfair legislation of the past and in opening up the development of this natural resource on very broad lines and under conditions which protect the Government—State or National—the public and the investors, and encourages good management. In none of the reports—the majority and minority and the unanimous recommendations—was there any suggestion of penalizing the investor. The use of the term franchise, rather than permit, in the minority report is significant and indicates what should be the true status of a water-power grant. The tendency toward federal rather than State control was also indicated in all reports."

Motor-Driven Combined Flushing and Sprinkling Machine

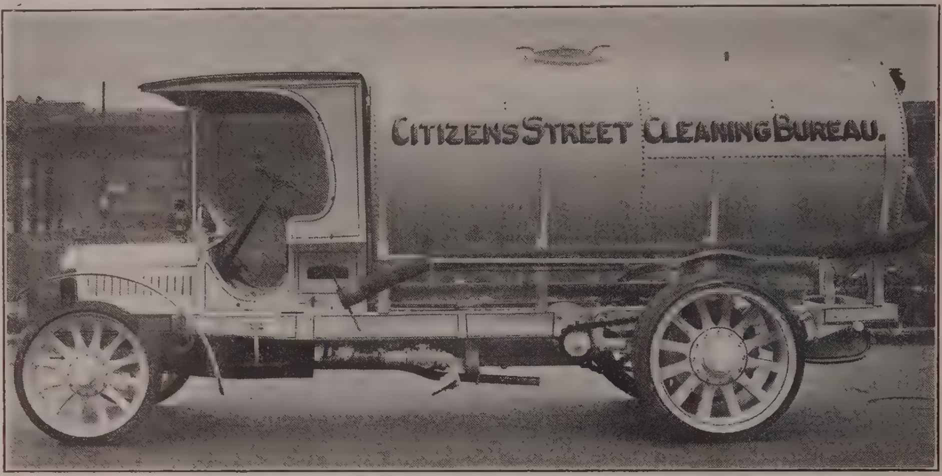
Automobile for Street-Cleaning Service Equipped with Separate Geared Drive Operating Centrifugal Pump

A motor-driven combined flushing and sprinkling machine has recently been put to work on the downtown streets of Chicago covered by the Citizens' Street Cleaning Bureau. It takes the place of two sprinkling wagons and two flushers. The outfit was put together by the International Motor Company at the shops of the Temple Pump Company in Chicago from specifications drawn up under the direction of Mr. Richard T. Fox, general manager of the Citizens' Street Cleaning Bureau, by Mr. J. W. Ingels, inspector.

A feature of the design is the utilization of a separate geared drive to operate an American centrifugal pump through a sliding friction gear, which permits the pump to run whenever the motor is running regardless of the speed of the truck itself. This is obtained, as shown in the illustration, by an independent pump shaft-driven by spur gears from the flywheel of the motor, which transmits power through beveled gears to the disengaging clutch with friction drive for variation in speed. Operation of the vertically placed pump between the rear wheels is, therefore, effected by a lever in the cab. The pump has a capacity of 450 gal. per minute. It discharges through a 3½-in. line to a point midway between the wheels, where it branches to a sprinkling head and to a Lunkenheimer flushing nozzle placed 8 in. above the pavement.

The tank, which is 55 in. in diameter and 11 ft. 7 in. long, and holds 1450 gal., is made of 3/16-in. boiler plate with three splash plates on the inside and with a screwed manhole on top. Connection to the pump suction is made through a flange just back of the pump. A 4½-in. filling plug with screen and check valve is inserted on the rear end near the bottom.

Nozzle pressures up to 80 lb. can be attained, but ordinarily a pressure of 30 lb. is the maximum used. The outfit is mounted on a 6½-ton Saurer truck.



Combined Flushing and Sprinkling Automobile for Street Cleaning

Valves controlling and regulating the flushers and sprinklers are operated from a bank of levers in front of the driver. There are four levers for the sprinklers, two for the flushers and one for the pump transmission. Ordinarily the speed practicable is about 6 miles per hour. The widest streets, such as State Street, which is 70 ft. wide, require for flushing four trips, but only two trips are necessary on 38-ft. streets. Water is carried for flushing about three blocks four times over. In preliminary trials the whole area cared for by the bureau, 118,800 sq. yd., was flushed in less than eight hours.

Effect of Hot Lard on Concrete

By J. NORMAN JENSEN, Chicago

Most of the old buildings in the Union Stock Yards of Chicago are of ordinary mill construction. As these buildings have occasionally been destroyed by fire and other causes the owners have replaced them with fireproof structures. For perhaps 90 per cent of the new work reinforced concrete has been used, and has given complete satisfaction. In one case, however, the use of concrete as a finished floor was not entirely satisfactory. In one of the buildings used for the refining of lard the floor had been pitted from ¼ to ½ in. in some places. This floor contained large kettles in which hog fat was boiled. Occasionally these kettles boiled over and some of the hot lard spilled on the floor. Wherever the hot lard came in contact with the finished concrete it ate a hole in the floor. This pitting was not caused by wear, as there was practically no trucking on the floor. Although the finished floor was less than one year old, it had to be replaced by a brick floor. This brick was of special make, only 1¼ in. thick. The joints were filled with cement mortar.

Progress on the Panama Canal

Summary of the Engineering Features of the Report of Col. George W. Goethals, Chairman of the Isthmian Canal Commission, for the Year Ended June 30, 1913

COMPLETION of the excavation of the Panama Canal prism to full depth and a bottom width of at least 200 ft.—except at Cucaracha, where slides interfered with the progress in the Culebra Cut—and the finishing of all concrete work at the locks are the announcements in Col. George W. Goethals' annual report for the year ended June 30, 1913, which indicate how near to its goal the great Isthmian waterway has advanced during the past year. The passage of commercial vessels through the Panama Canal is now dependent only upon the time required for dredging proper channels through the slides, and everything points to the completion of this work in ample time for the official opening of the canal on Jan. 1, 1915.

First Division

The first division of the chief engineer's office, under Col. H. F. Hodges, assistant chief engineer, continued in charge of the design of the locks, dams, regulating works and accessories. The designing work for the locks, including all detail drawings needed by the working force in the field, as well as for the spillways, approach piers and wing walls, was completed.

The mechanical installation of the 120 cylindrical valves was completed June 1, 1913, and the electrical work of installing control panels and cables with necessary conduits for these machines was 41.6 per cent complete for all locks.

Tests of discharge were made on the cylindrical valve and the three rising stem gate valves in the spillway. The first series of observations, with heads varying from 8.94 to 29 ft. above the center of the valve, gave values of the coefficient of discharge for the cylindrical valve of 0.445 as the mean of three observations, and for the gate valves of 0.592 as the mean of six observations. These observations were complicated by the screens at the culvert entrances, which became clogged with dirt and debris. After the screens had been removed a considerably increased coefficient of discharge resulted for the rising stem valves; the average of 58 observations, with an average head of 29.81 ft. above the middle point of the valve, gave a value of the coefficient of 0.68. It is probable that a less favorable value will be obtained in operating the lock culverts on account of the friction and changes of direction in the stream after it passes the valve. The cylindrical valve was removed before the latter and more reliable observations were made.

During the year 14 gates and 1 caisson for the spillway at Gatun and 8 gates and 1 caisson for the spillway at Miraflores were erected complete, under contract, and the contract closed. The gates at Gatun were installed in position on the dam. The Miraflores spillway was under construction and not ready for them. The draft tubes for the hydroelectric station, which are placed on the east side of the spillway dam at Gatun, were completed.

The construction and erection of the lock gates was continued during the year under contract with the McClintic-Marshall Construction Company dated June 21, 1910 (see Engineering Record, Nov. 8, page 513). The date of final completion for all gates is fixed at Jan. 1, 1914, for Gatun and Pedro Miguel, and March 1, 1914, for Miraflores. From the progress being made by the contractors these dates will be anticipated unless some unforeseen contingency should arise. The total weight of all gates on the canal, excluding pumps, floats and float switches, motors and conduits, and other electrical apparatus, the castings for attaching the operating struts, and the miter forcing machines, is 57,552 tons.

The results of tests of chain fenders for the locks seem to warrant the belief that a vessel, unless of very great size or moving at excessive speed, can be checked or stopped without breaking the chain, provided the latter is structurally sound. The chain is stretched across the lock at either of two levels, according to the stage of the tide. The chain is endless and, by a stop mechanism, may be operated electrically from the central control house. The chain that passes through either hawsepipe is connected with the operating machinery and is raised or lowered, that which passes through the other hawsepipe remaining at rest.

All the remaining parts of the towing track material to be furnished under contract were delivered on the Isthmus before the close of the year. An order was placed for the required number of towing locomotives on the design submitted by the General Electric Company, abandoning the design of the commission.

Lock Control

During the year the control scheme for the various locks was completed and contemplates the control of every piece of machinery in the lock walls from a central station, situated on the center wall of the upper locks, where an uninterrupted view of the entire lock or flight of locks may be had. In this house is located a control switchboard connected with every local control panel and indicating mechanism. The switchboard is so arranged that the indicator and control switch of each gate or valve machine is placed in the same relative position to other indicators and control switches as that occupied by the actual machines. By means of red and green lights and small models of gates and valves operated by synchronous transmitting mechanisms the operator in the control tower is able to tell at a glance the condition in any part of the locks from the switchboard indications.

The generating equipment for the hydroelectric plant was delivered during the year, including the main generators and turbines, with exciter sets, traveling crane, penstocks, head gates and operating machinery. The steelwork for the hydroelectric station was purchased under contract, and the delivery was completed before the end of the year. The erection of the penstocks is complete and all turbines have been set. The balance of the work of installation is dependent upon the completion of the building for housing the electrical equipment. It was decided to install for the transmission line an overhead system of 44,000 volts, extending from Balboa to Cristobal, and connecting the Gatun hydroelectric power station with the present Miraflores steam power station, so that they may be operated separately or in parallel, as necessary. Four substations are provided, and located at Cristobal, Gatun, Miraflores and Balboa.

Atlantic Division

The work of the Atlantic division embraces the construction of the locks and dam at Gatun, the quarry at Porto Bello, the sand supply, the breakwater for the shelter of shipping and protection of the channel at Limon Bay, and the municipal improvements in Colon. The work of the division is in charge of Lieut.-Col. William L. Sibert, division engineer.

At the beginning of the fiscal year dredges were at work excavating an area north of the caisson sills of the locks, within which the flare or wing walls and the north approach pier were to be constructed. The wing walls are built on rock and the approach pier partly on rock, but for the greater part on piling. For the former it was necessary in some places to remove material to a depth of 70 ft. below sea level in order to uncover the rock, and as the dredges could excavate only to a depth of 41 ft., the level of the pool had to be lowered for them to perform the work. To accomplish this a clay dam was built across the cut excavated by the dredges to reach the area, and, when completed, the water in the resulting inclosure was lowered by pumping with the dredges.

Gatun Locks and Dam

Last fall it was estimated that the concrete work of the Gatun locks would be completed by July 1, 1913. By shortening the north approach pier 200 ft. all the concrete, except miscellaneous finishing, was completed on June 14, 1913. The miscellaneous work consists of lamp-post bases, snubbing-button bases, mooring-post bases, stair-well parapets, paving and the closing of a few openings which were left for construction purposes. Of the amount of concrete laid during the year, 2742 cu. yd. were produced by auxiliary mixers, 1944 cu. yd. were mixed by hand and the balance by the 2-yd. mixers installed in the construction plant.

The back filling of the side walls and the filling of the center wall were made of material obtained from borrow pits and from the canal prism, aggregating 637,226 cu. yd., all of it removed by steam shovels.

At the close of the previous fiscal year the Gatun Dam had been raised to an elevation of 103.35 ft. for a length of 1000 ft. east of the spillway, and for the balance of this portion of the dam the dry fills had reached a general elevation of 98 ft. and the hydraulic fill between them a general elevation of 85 ft. On the portion of the dam west of the spillway the north and south fills had reached a general elevation of 98 ft. and the hydraulic fill an elevation of 87 ft. at the spillway and 78 ft. at the drains located in the northwest corner of the dam. Sufficient material had been added to raise the dam to practically its full height, with 3 to 5 ft. additional along the axis to allow for settlement. The dry fill was secured from the borrow pit which had been opened during the previous fiscal year, beyond the west end of the dam, and the clay used to top off the hydraulic fill from borrow pits north of the dam and in the vicinity of the locks. From two to six steam shovels were engaged in procuring this material and removed 2,159.159 cu. yd., borrow pit measurement, of which 922,877 cu. yd. were designated as rock. The hydraulic fill was supplied by three pipe-line suction dredges operated in borrow pits 1½ miles distant, the maximum lift being 100 ft. The total amount handled, borrow pit measurement, was 493,145 cu. yd. The hydraulic fill was stopped in September, 1912.

It is estimated that the dry fill deposited aggregated 1,714,367 cu. yd., or a loss of 21 per cent of the borrow-pit measurement, due to consolidation. Of the hydraulic fill, it was estimated that there was a loss of 324,141 cu. yd., or 65.8 per cent, due to waste through drain pipes, leakage and consolidation. The total consolidated fill for the year aggregated 1,967,841 cu. yd. The cost of the dry fill in place amounted to $0.3755 per cubic yard and of the hydraulic fill $0.2654 per cubic yard.

Slides at Gatun

On the morning of Aug. 29 a bulging and sliding movement began along the north slope of the dam near the west end. The movement continued through Sept. 1 and ceased Sept. 2. The maximum vertical settlement of the track at the top of the dry fill, El. 101, was 20 ft., extending for a distance of 750 ft. along the crest, affecting not only the hydraulic fill but the north slope of the dry fill to the south of it. The total lateral displacement along the 85-ft. contour was 33.9 ft., on the 50-ft. level 31.2 ft. and on the 30-ft. contour 18.1 ft. The south slope of the dam remained undisturbed. The slope of the portion of the dam which moved was originally fixed at 1 on 5, and this was authorized "because the rock is near the surface and fairly horizontal. The only thing to be provided against in this slope is the slipping of the dam material on itself." Because of the character of the material along this portion underlying the structure there could be no question that the movement was within the dam itself. Wash borings clearly indicated that the relative proportions of hydraulic fill and dry fill which would bring about the desired section of hydraulic fill—wedge shape, with the point down—had not been secured, but that on the contrary the hydraulic fill in section was the opposite of this. Furthermore, it was evident that provision had not been made against the slipping of the dam material on itself. As in the case of the movement on the north face of the east portion of the dam, the toe was heavily reinforced and the slope flattened to an average of about 1 on 7.67.

Riprap for Wave Protection

To prevent injury to the dam that might result from wash of the south slope by waves, concrete paving was at first considered, but because of settlement, due to consolidation and the irregularity of the surface, it was decided to use riprap laid on broken stone. It was estimated that waves 5 ft. in height might at times exist. A layer of crushed stone, supplied by Ancon quarry, was laid over the dam from El. 74 to El. 92 to a thickness of about 4 in. Over this a sufficient thickness of riprap was placed to protect the broken stone from the action of the waves. An area of 115,740 sq. yd. was covered with crushed stone, of which 15,740 cu. yd. were used, completing this portion of the work in April at a cost of $2.4536 per cubic yard in place. The riprap stone placed at the close of the fiscal year aggregated 68,730 cu. yd., covering an area of 102,030 sq. yd., at a cost in place of $0.6574 per cubic yard.

The water in the lake, controlled by the sluices, was held at about El. 32 until the last week in August, when the completion of the guard gates and caisson sills of the locks permitted it to be raised. The elevation of the lake at Gatun on July 1, 1913, was 49.15.

Concrete laid in the Gatun spillway for the year aggregated 21,719 cu. yd., at a cost of $8.1227 per cubic yard. The excavation amounted to 175 cu. yd. and cost $2.3913 per cubic yard. The total amount of concrete thus far placed in the spillway was, therefore, 224,132 cu. yd., at an average cost of $7.4838 per cubic yard.

Architectural features were added to the plans prepared by the first division of the chief engineer's office for the hydroelectric power plant to be constructed below the spillway at an estimated cost of $147,950 and its construction undertaken by the Atlantic division. The excavation was completed and during the year 14,948 cu. yd. of material were removed—rock and earth—at a cost of $0.4022 per cubic yard; in the preparation of the foundations 11,684 cu. yd., costing $1.7973 per cubic yard, were removed; the total excavation to date, therefore, including the preparation of foundations, was 98,751 cu. yd., at an average cost of $0.5486 per cubic yard.

The total amount of rock received from Porto Bello and placed on the breakwater for Limon Bay was 183,762 cu. yd., of which 102,508 cu. yd. were handled from barges to Lidgerwood cars by locomotive cranes and subsequently plowed off. The balance was placed by derrick barges. In addition to this source of supply about 220,433 cu. yd. of rock removed from the channel by the dredges were dumped on the breakwater. The cost of Porto Bello rock placed on the breakwater averaged $4.8250 per cubic yard.

The existing water supply for Colon was not adequate and plans were submitted for the construction of a modern filtration plant and pumping station to take the place of the present plant. This project, approved on July 12, 1912, at a total cost of $193,768, includes an aeration basin, sedimentation basin, filters and clear-water basin. All work between Gatun Lake and Brazos Brook reservoir is practically complete. The pumping station is completed ready for the installation of the machinery; the filter building is completed up to and including the operating floor; the sedimentation basin is 75 per cent completed, and the foundations and floors of the mixing chambers and aeration basin are laid.

Central Division

The work of the Central division embraces the excavation between the Gatun Dam and Pedro Miguel Locks, including diversion channels, the construction of the Naos Island Breakwater, municipal improvements in the various settlements included within the division limits, and such sanitary engineering work in the same area as is prescribed by the sanitary department. The work is in charge of Lieut.-Col. D. D. Gaillard, division engineer.

Excavation for the canal prism during the year was confined to Culebra Cut, and 12,582,124 cu. yd. were removed. In addition to this, 155,376 cu. yd. were excavated in changing portions of the Obispo diversion and 35,888 cu. yd. outside of the canal prism for auxiliary work; the total amount of material handled by the central division, therefore, aggregated 12,773,388 cu. yd., of which 10,098,099 cu. yd. were classed as rock. The estimated amount removed because of slides was 5,899,200 cu. yd., and of this amount 1,593,070 cu. yd. of material were taken from the upper reaches of the banks to reduce the quantity to be taken from the bottom, or as a preventive measure against slides and breaks. In other words, 46.67 per cent removed from the Cut was due to slides, as against 35.90 per cent during the previous fiscal year.

The amount remaining to be removed was again increased at the close of the year, and aggregates for the Culebra Cut 8,200,000 cu. yd.; in other words, there will be an increase for the central division of 9,280,237 cu. yd. over the estimate submitted in the last annual report. Of this total remaining, 1,324,944 cu. yd. were inside the canal prism lines and 6,860,500 cu. yd. estimated for slides, which estimate includes the amount for benching back of the banks so as to relieve the pressure which, crushing the underlying strata, may either increase the extent of existing slides or cause new ones. The total amount of material due to slides so far removed aggregates 22,570,200 cu. yd., or an increase of 2,304,200 cu. yd. over that estimated in the last annual report. Slides and breaks increased as the Cut was deepened. No treatment has proved effective for slides when once developed except that of excavating and hauling away material from the moving mass until the slide comes to rest or until the angle of repose for the material in motion is reached.

Cucaracha Slide

The predictions of the geologist in the last annual report, with reference to the Cucaracha slide, that "the end of the activity of this slide is now well in sight, however, because all loose surface stone and clay has almost slid off, exposing several large dikes and flows of basalt which would successfully maintain in place most of the remaining material," have not been realized. The bottom grade of the canal had been reached and the widening cuts had progressed satisfactorily until within approximately 60 ft. of the line of the prism on the east side, when on Jan. 20 the basalt rocks broke and there slid into the Cut approximately 2,000,000 cu. yd. of material extending completely across the Cut, topping the tracks on the 67-ft. level and completely stopping the passage of trains from the north. Bottom grade was subsequently reached for sufficient width to put in drainage pipes for handling the water from the north, but the rains saturating the loosened material occasioned a flattening of the slope, thus causing another movement, and the weight of the superimposed mass broke the pipes. Work was continued on the slide during the year, but principally for the purpose of maintaining the tracks on the 67-ft. level open for the passage of trains. This slide at the close of the fiscal year covered an area of approximately 50 acres. The total amount removed thus far since July, 1905, when it began moving, is 3,859,500 cu. yd., leaving approximately 1,500,000 cu. yd. still to be removed. The material on the south side of the slide is practically all clay, the middle of it consists of clay and spalls, and the north side of it rock with a mixture of clay. The clay and the clay and spalls can be easily handled by suction dredges, while the material on the north side can be handled by dipper and ladder dredges.

Other Slides

From the West Culebra slide 1,922,700 cu. yd. were removed during the year, including material taken from the upper benches, making a total from the time this slide developed in October, 1907, of 8,687,600 cu. yd., leaving approximately 2,390,000 cu. yd. to remove, if all the material on the top of the bank is taken out. This slide covers an area of 68 acres.

From the slide at East Culebra 1,676,300 cu. yd. were removed during the year, making a total of 5,966,200 cu. yd. removed since the slide first developed in January, 1907, and it is estimated that 2,000,000 cu. yd. remain. This slide covers an area of approximately 55 acres and extends from the north side of Gold Hill for approximately 5500 ft.

A break occurred on Aug. 20, 1912, north of the one previously reported at La Pita Point, which turned the Obispo diversion into the canal, flooding it and effectually stopping all steam-shovel work to the north. These shovels were removed and an earth dam built across the Cut south of the break to protect the Cut between it and the summit, which area was then freed from water by pumps, and a temporary channel constructed for the diversion. The shovels were concentrated on the summit stretch and continued there and on the upper banks until the dry season. After a new channel had been excavated for the Obispo diversion the slide was attacked and 181,100 cu. yd. were removed during the remainder of the year.

Steam-Shovel Operation

All trains loaded in the Cut were hauled out at either end to the dumps. On account of the grades that had developed due to deepening the Cut, it was necessary to use an average of seven engines per day as pusher engines to get these trains out in carrying the loaded trains up the inclines at either end. With a contracted area of operation, the steam shovels were placed closer together and necessitated an average of six locomotives daily to handle the trains to and from the shovels, besides those used in hauling the trains to the dumps.

Due to the development of slides and beginning Feb. 20, 1913, the split-shift system was inaugurated on shovels working in the slides and on the upper benches, so as to secure 12 hours' work per day. While this increased the cost to some extent, it was more than justified, after the decision had been reached to admit the water into the Cut in October, in order to remove as much of the remaining rock in the dry as possible.

The dumps in use during the year were those at Miraflores, Balboa, along the line of the railroad relocation north of Gamboa, swamp lands in the vicinity of Ancon, and a new dump opened along the line of the Panama Railroad south of Pedro Miguel. A total of 284,755 cu. yd. was dumped on the east side of the cut. At Miraflores 1,288,262 cu. yd. were wasted; 3,985,129 cu. yd. were used for reclaiming swamps at Balboa and wasted on the Balboa dump; 440,725 cu. yd. were used for filling swamp lands northeast of Ancon Hill, and 4,376,080 cu. yd. on the Panama Railroad relocation dumps between Caimito and Gamboa. During the year 90 acres were filled in at Balboa, making a total of 474 acres in all reclaimed at this point. Between Balboa Y and Sosa Hill 54 acres of marshy land that it was impossible to drain properly were filled during the year. In addition, 487,108 cu. yd. of waste material were furnished other divisions and the Panama Railroad.

Naos Island Breakwater

The Naos Island Breakwater, extending from the shore at East Balboa to Naos Island—a distance of 3.29 miles—is constructed for the purpose of cutting off silt-bearing currents that would fill the excavated channel in the Pacific and make navigation of the channel more difficult by reason of cross currents. As noted in the last annual report, considerable difficulty was experienced by the method of construction then in vogue, which consisted of dumping material from a single trestle extended in advance of the dump. A plan suggested by Mr. W. G. Comber was considered by a board and adopted. The plan consists of the building of a double trestle extending to Naos Island, dumping to be done on either side, thereby spreading the fill over the treacherous bottom, and carrying it to mean tide as far as the island. When this was done, filling was to commence at the island carrying it to full height. Should the trestle fail, ample length would be left for dumping between the break and the end of the finished portion, while the broken portion was being repaired by pile drivers. On June 30, 1913, the trestle had been entirely completed and filled, with the exception of a stretch about 600 ft. long. The total amount of material used for this purpose aggregated 653,242 cu. yd. The soft material was pushed out and up, forming a ridge of mud, intermixed with stones that had been dumped in and carried up by the soft material, parallel to the breakwater and at a distance of approximately 100 ft. from it. The total amount expended on the dike by the Central division and the Pacific division up to June 30, 1913, was $384,540.89, or $22.14 per linear foot.

The average division cost of excavation for the year, including plant charges and all items which entered into its accomplishment, was $0.5525 per cubic yard. The total amount removed from the Central division since American occupation up to the close of the fiscal year was 107,139,181 cu. yd., at an average cost of $0.7105 per cubic yard. Of this total, 93,305,975 cu. yd. were removed from Culebra Cut.

Pedro Miguel Locks

After the resignation of Mr. S. B. Williamson, the Pacific division was abolished, effective Dec. 12, 1912, and the fifth and sixth divisions of the chief engineer's office were organized. The fifth division has charge of the construction of the locks, dams, spillway, excavation in the dry in the canal prism between and below the locks, the operation of Ancon quarry, and municipal engineering work. The work is in charge of Mr. H. O. Cole as resident engineer.

Excavation in connection with the Pedro Miguel Locks was completed during the year by the removal of 3044 cu. yd. from the locks proper at a cost of $0.4078 per cubic yard. The total amount of excavation for the locks, approach piers, and guide walls, including the preparation of foundations, was 1,319,742 cu. yd., and cost on an average $1.0248 per cubic yard. The total amount of concrete placed during the year was 58,367 cu. yd., mixed entirely by auxiliary mixers consisting of two 2 cu. yd. mixers at the north end of the locks on the west side and of an average of 3.05 ½-yd. mixers which were moved about as necessity required. The concrete was handled either by derricks and locomotive cranes or dumped direct into place through chutes. Of this total 39,465 cu. yd. were plain concrete at a cost of $6.5432 per cubic yard, and 18,902 cu. yd. were reinforced concrete at a cost of $9.7989 per cubic yard. The total amount of concrete placed prior to July 1, 1913, in the Pedro Miguel Locks was 906,293 cu. yd. at an average cost of $5.5061 per cubic yard.

The west dam at Pedro Miguel, consisting of rock-filled sides and puddled-clay core, was completed and the top finished at El. 107 with clay. The north face was riprapped with hard stone at the 85-ft. level. During the year 114,117 cu. yd. of fill were added, making the total in the dam 696,558 cu. yd. The average division cost during the year was $0.3312 per cubic yard; the average division cost for the entire dam was $0.4471 per cubic yard.

Miraflores Locks

The Miraflores Locks, including excavation for foundations and the placing of concrete, were carried to completion during the year. The foundation work for the lower west wall was seriously interfered with and retarded by slides and by the water-bearing strata of the banks. The construction plant, consisting of four berm and four chamber cranes, supplied concrete in the manner described in the last annual report. The total amount of concrete laid in the Miraflores Locks during the year was 450,792 cu. yd., of which 402,607 cu. yd. were plain concrete at an average cost of $5.0273 per cubic yard and 48,185 cu. yd. of reinforced concrete at an average cost of $10.8023 per cubic yard. Of the total amount, 308,914 cu. yd. were laid by the four berm cranes. The chamber cranes handled 218,135 cu. yd. of concrete and 92,359 cu. yd. of fill for the center wall. The concrete was furnished in part by the mixers on the berm cranes and by the 2-yd. mixers installed on the east wall which operated from July 1, 1912, to Oct. 26, 1912, producing 97,603 cu. yd. In addition to the regular plant, an average of 3.12 half-yard portable mixers were used throughout the year.

Concreting Locks

The total amount of concrete laid in the Miraflores Locks up to the close of the year was 1,476,895 cu. yd., at an average cost of $5.024 per cubic yard. The concrete work in the locks proper was completed on May 17, except the reinforced concrete floor and stairway in the middle wall at the junction of the upper and lower locks, which were completed on June 10.

The total amount of concrete laid in the Pacific Locks July 1, 1913, aggregated 2,382,983 cu. yd., at an average cost of $5.2033 per cubic yard.

During September and October, 1912, 9896 cu. yd. were excavated for the spillway dam by the hydraulic method. Owing to the limited space and excessive rainfall this method had to be abandoned and no work was done until the beginning of the dry season, when excavation was resumed by the use of steam shovels and also by hand loading into skips which were handled by derricks and locomotive cranes. To the credit of those engaged in the construction, the structure was completed, notwithstanding the natural difficulties and the delays for which they were not responsible, on Sept. 1, 1913. In addition to the material removed by the hydraulic method, 124,775 cu. yd. were excavated by steam shovels, hand, derricks, and cranes, completing the excavation for the spillway dam at an average cost of $1.6835 per cubic yard.

Concreting Spillway

The total amount of concrete laid in the spillway was 64,142 cu. yd., of which 63,707 cu. yd. were plain concrete at an average cost of $5.7556 per cubic yard, and 435 cu. yd. were reinforced concrete at an average cost of $19.60 per cubic yard. In laying this concrete narrow-gage tracks were laid from the berm cranes located on the east side of the locks to the south toe of the dam, ending in various spurs leading to derricks which handled the concrete mixed by the berm cranes and delivered on transfer cars in 2-yd. buckets. The berm cranes mixed for use at the spillway 27,619 cu. yd., bucket measurement. In addition, an average of 1.43 1-yd. mixers and one half-yard mixer supplied 38,551 cu. yd., bucket measurement.

The west dam at Miraflores was completed during the year, with the exception of the junction of the dam with the backfill along the west lock wall. The hydraulic fill in the west dam was completed during the previous fiscal year, and the total amount of dry fill added was 418,375 cu. yd., at a cost of $0.4076 per cubic yard. As this dry fill was advanced over the hydraulic fill the softer material was crowded to the center and increased in height and, as it was not sufficiently hard to bear the tracks, an outlet was cut on the west side of the dam, through which as much of the soft material as possible was crowded out, assisted by a water jet. What remained was pushed over on the west slope of the dam by raising and crowding the east dry fill. In this way a complete covering was made to full grade, leaving relatively little of the soft material within the dam.

The total amount of dry excavation in the prism, as shown by cross-section measurements, was 3,120,851 cu. yd., at an average division cost of $0.6622 per cubic yard.

The hydraulic excavating plant continued at work until Dec. 1, 1912, when it was taken out of service owing to the fact that most of the remaining excavation was hard rock. The material removed by this method was used for reclaiming tidal swamp lands east of and adjacent to the canal prism. The total amount removed during the year was 451,631 cu. yd., at a cost of $1.0113 per cubic yard, making a total removed by this method of 1,549,904 cu. yd., at an average cost of $0.6959 per cubic yard. At this cost the entire plant charge, $432,841.92, was absorbed.

This plant was still in serviceable condition, and the suggestion was made by Assistant Engineer W. L. Thompson that at least a part of it be utilized in sluicing the soft material which was found on the north side of Gold Hill and on the top of the east bank of the Culebra Cut. The proposition did not appeal to the officials of the Central division, but after the renewed activity of Cucaracha slide it was decided to make use of the sluicing plant for this purpose. The location selected for the pumps and pipe line was such that the rear of Cucaracha Hill could be taken off and washed back into the valley to the east by the use of relay pumps and, further, whatever material remained on the Cut side of Cucaracha Hill could be washed down to the dredges, thereby finishing up Cucaracha slide for good and all. These considerations led to the adoption of this method of sluicing, and the work was placed in charge of the resident engineer of the fifth division. Sluicing was begun on June 17, 1913, and 57,274 cu. yd. were removed by this method at an average cost of $0.1835 per cubic yard.

Culebra Cut

It was decided in February, 1913, to flood Culebra Cut in October, 1913, by removal of the dike at Gamboa. It was estimated that about 350,000 cu. yd. had to be removed from the lake section north of Gamboa and that this could be done most economically by dredging; the Cucaracha slide, which consists largely of clay and small spalls, could not be removed economically by steam shovels after the heavy rains had set in, but could be handled efficiently by suction dredges; the conclusion was reached, therefore, that subsequent to the admission of water into the Cut in October the work remaining could be handled most expeditiously and economically by use of the dredging fleet. To get the fleet in condition to handle the work by that time and to take care of what may remain at the entrances, it naturally followed that best results could be accomplished by concentrating all dredging under one head; consequently, effective May 1, this was done, and the division organized with Mr. W. G. Comber in charge as resident engineer.

The fleet on the Atlantic side of the canal removed during the year 5,730,379 cu. yd. of earth and 753,029 cu. yd. of rock, at an average cost of $0.2093 per cubic yard. On July 1, 1913, there remained to be removed from the prism 1,837,000 cu. yd. of earth and 99,600 cu. yd. of rock. At the end of the fiscal year 40 ft. of water could be carried through approximately the first mile and a half of the channel, 35 ft. through the next 5 miles, and between this and the locks the depth varied from 10 to 30 ft. The siltage in the canal prism for the year was 2,084,000 cu. yd.

At the Pacific entrance of the canal the total amount removed from the canal prism by dredges during the year aggregated 4,321,956 cu. yd., of which 1,047,929 cu. yd. were rock. The average cost during the year was $0.3238 per cubic yard. At the close of the fiscal year there remained to be removed from the prism 1,847,774 cu. yd. of earth and 1,600,000 cu. yd. of rock.

Anticipating the necessity for completing the Cut by dredges, a contract was entered into on Jan. 16, 1913, for the construction and delivery at Colon of two dipper dredges of the largest and most powerful type in use. They are to be equipped with 15-yd. buckets or dippers for dredging soft material and 10-yd. buckets for rock. Deliveries are expected at tidewater in the United States, ready for shipment to the Isthmus, Dec. 1, 1913, and Jan. 1, 1914.

Terminal Facilities

The second division has charge of the design and construction of the terminal facilities, meteorological work, supervision of the mechanical division, and of expenditures and allotments for the work. It is in charge of Mr. H. H. Rousseau, United States Navy, as assistant to the chief engineer.

The Pacific terminals, which are being constructed by the commission, will consist of a main dry dock capable of docking any vessel that can utilize the locks, a smaller dry dock for the use of smaller craft, a plant for supplying coal and fuel oil to vessels, the necessary wharves and piers for commercial purposes, and the permanent shops for use in connection with the dry docks.

The Atlantic terminals consist of wharves and piers at Cristobal, including the Cristobal mole, all of which are being constructed by the Panama Railroad at its own expense, and the main plant for supplying coal and fuel oil to vessels; the cost of the coaling plant will be divided between the commission and the Panama Railroad Company, while the commission will furnish facilities for oil.

The wharves and docks contemplated will consist of a quay wall 1238 ft. long between the head of slip 1 and the northeast end of the new Panama Railroad concrete dock, and one pier 1000 ft. long by 201 ft. wide. Permanent walls will be built at the ends of the slips, each 303 ft. wide, and so constructed that part of the length of each will afford landing places for small boats. Including the length of the wharf constructed for the Panama Railroad and completed during the previous fiscal year, the total water frontage under construction will be about 4650 ft. long.

Fortifications

By the act approved Aug. 24, 1912, an appropriation of $1,000,000 was made for the gun and mortar batteries for the defense of the canal against naval attack, making the total appropriated $3,000,000, which is sufficient for the completion of this portion of the work. In addition, $200,000 were appropriated for land defenses.

Work was continued during the year on the gun and mortar batteries. The detailed surveys necessary for the location of land defenses were well advanced to completion and arrangements made to begin work on July 1, 1913, on the construction of redoubts in accordance with plans prepared by a board appointed for the purpose and approved by the Secretary of War.

During the year 416,542.5 cu. yd. of excavation, at an average cost of $0.9225 per cubic yard, were done; 131,952.8 cu. yd. of concrete, at an average cost of $7.0670 per cubic yard, were laid; 93,808 lin. ft. of piling, at a cost of $0.4311 per linear foot, were driven; and 100,957 cu. yd. of filling, at a cost of $0.1720 per cubic yard, were done by one of the dredges. The amount expended for gun and mortar batteries was $1,432,767.01, for surveys $41,790.95.

The work was in charge of Lieut. George R. Goethals, United States Army, assisted by Lieut. A. H. Acher, United States Army, and Mr. R. M. Elder and Mr. H. P. Warren as superintendents of construction.

Cost Keeping

The methods of cost keeping adopted on Jan. 1, 1910, were continued throughout the year. The cost-keeping accountant, Mr. Ad. Faure, reports directly to the chief engineer. Although the details of costs furnished have greatly increased in the past year, the expense of securing this data has decreased from about $3,600 per month to $3,000 per month.

Excavation by steam shovels in the Central division shows an increased cost over last year of $0.0410, the principal item of increase being in the cost of repairs to equipment—$0.0297.

In the Atlantic division the costs for dredging in the prism were lower this year than last, due to the larger ratio of material excavated by pipe-line suction dredges. In the Pacific division the cost was higher than last year, due to the larger ratio of rock excavation and the increased depth, which is attended with additional expense because of the great tidal variations.

Hydraulic Excavation.—Hydraulic excavation in the channel below Miraflores Locks was concluded in November, 1912, and the plant re-erected at a point north of Gold Hill to sluice the top banks in order to relieve the pressure. Operations began on June 16, and to the close of the fiscal year 57,274 cu. yd. of material had been removed, at a division cost of $0.1835 per cubic yard, including an arbitrary of $0.1000 per cubic yard for plant. This work is being performed by the fifth division, chief engineer's office.

Masonry.—There was a total of 771,907 cu. yd. of masonry laid in the locks and spillways during the year, as against 1,443,570 cu. yd. during the previous year. This is inclusive of masonry laid by the first division in connection with the installation of operating machinery. The costs per cubic yard for the masonry were: Gatun Locks, $7.2794; Gatun spillway, $8.1227; Gatun power house, $8.5739; Pedro Miguel Dam, $5.0240; Pedro Miguel Locks, $7.5976; Miraflores West Dam, $4.3330; Miraflores spillway, $5.8497; Miraflores Locks, $5.6445. Plain concrete shows increased cost over last year in all projects, except Gatun Locks, due to reduced quantities of concrete laid and to the use of a larger ratio of auxiliary mixers. At Gatun Locks plain concrete shows a decrease of $0.5934, principally in the cost of sand and stone, in the expense for steel forms and in the arbitrary for plant, the decrease in the cost of sand and stone being due to readjustment of stock prices (revised cross-section measurement of the stock piles having shown more stone in storage than was carried on the books), and to securing sand from the borrow pit at Gatun instead of from Nombre de Dios. At Miraflores Locks plain concrete shows an increase of $0.4406 per cubic yard, principally in cement, mixing, wood forms, and placing. Fluctuations in the cost of reinforced concrete are due to the different classes of concrete laid during the two years.

Gatun Dam.—The dam at Gatun was increased by 1,714,367 cu. yd. of dry fill at a division cost of $0.3755 per cubic yard, and 169,114 cu. yd. of hydraulic fill at a division cost of $0.2654 per cubic yard. At the close of the year there were in place at Gatun Dam 11,578,268 cu. yd. of dry fill at a cost of $0.4063 per cubic yard, and 10,124,082 cu. yd. of hydraulic fill at a cost of $0.2933 per cubic yard.

During the fiscal year 1913 no filling for the Colon Breakwater was secured from Toro Point; 183,762 cu. yd.of large rock secured from Porto Bello quarry were placed in the breakwater at an average division cost of $4.8250 per cubic yard. This yardage is the volume of rock in the bank. Last year 65,133 cu. yd. of this rock were placed in the breakwater at a division cost of $4.3064 per cubic yard.

Ancon Quarry.—The Ancon quarry alone was operated during the fiscal year and produced 688,301 cu. yd. of crushed stone at an average cost of $0.7795 delivered in storage. To the close of the fiscal year this quarry had produced 2,558,578 cu. yd. of crushed rock at an average cost of $0.8572 per cubic yard delivered in storage. The Porto Bello quarry, which began operations in March, 1909, and closed down in April, 1912, produced 1,921,929 cu. yd. of crushed rock at an average cost of $2.4337 per cubic yard delivered in storage. There were secured from the Chamé sand pit 445,658 cu. yd. of sand at an average cost of $0.7111 per cubic yard delivered in storage. To the end of the fiscal year there have been secured from this source 1,741,196 cu. yd. of sand at an average cost of $0.7666 per cubic yard. From the pit at Nombre de Dios on the Atlantic side, which was opened in March, 1909, and closed in November, 1911, there were secured 785,893 cu. yd. of sand at an average division cost of $1.9176 per cubic yard delivered in storage. During the year there were secured from the borrow pit near Gatun dam 43,851 cu. yd. of sand at an average cost of $0.5188 per cubic yard.

Lock Gates.—To the close of the year the following amounts had been expended: On spillway gates and caissons at Gatun, $73,732.22; at Miraflores, $40,625.69. On spillway gate machines and their erection, at Gatun, $91,122.95; at Miraflores, $64,299.22. On lock gates and their erection, at Gatun, $2,225,084.30; at Pedro Miguel, $1,373,537.13; at Miraflores, $1,233,845.37. On fender chains, at Gatun, $3,836.95; at Pedro Miguel, $21.37. On emergency dams, at Gatun, $816,184.77, at Pedro Miguel, $512,480.47; at Miraflores, $38,803.75. On lock operating machinery, including towing-track system, concrete used in the installation of machines, etc., at Gatun, $2,592,232.64; at Pedro Miguel, $1,361,873.92; at Miraflores, $1,561,817.40.

Towing Track System.—For the towing-track system the following number of linear feet of return track were laid by the construction divisions at the various locks: Gatun, 10,527, average division cost $1.3261; Pedro Miguel, 4333, average division cost $1.1065; Miraflores, 5925, average division cost $2.5637; and by the first division at Gatun, 1449, average division cost $1.9273; at Pedro Miguel, 2043, average division cost $2.3678; at Miraflores, 1082, average division cost $0.6085 per linear foot. The number of linear feet of track, with rack installed by the first division, and the average cost per linear foot were: At Gatun, 21,000, average division cost $2.3128; at Pedro Miguel, 12,199, average division cost $2.0180; at Miraflores, 14,137, average division cost $1.2291.

In connection with the erection of operating machinery, installation of towing tracks, and decking, the first division had laid to June 30, 1913, 36,710 cu. yd. of concrete as follows: At Gatun locks, 16,706 cu. yd., average division cost $13.4124 per cubic yard; at Pedro Miguel locks, 10,190 cu. yd., average division cost $12.1460 per cubic yard; at Miraflores locks, 9814 cu. yd., average division cost $11.3013 per cubic yard.

The total expenditures for aids to navigation to the close of the fiscal year had been $377,041.63.

Terminals.—For the Cristobal terminals $14,488.14 had been expended, and for the terminal facilities at Balboa $1,943,971.09. There had been excavated in preparation of site 412,707 cu. yd. of material at an average cost of $0.5620 per cubic yard. In filling, 505,419 cu. yd. of material had been used at an average cost of $0.3992 per cubic yard. There had been dredged in preparation of the inner harbor at the latter point 1,771,814 cu. yd. at an average cost of $0.1547 per cubic yard. For the main dry dock there had been excavated 145,478 cu. yd. of material, and for the coaling station 58,221 cu. yd., at an average cost of $0.8461 per cubic yard. In preparing the foundations for the shops 29,684 cu. yd. of material had been removed at an average cost of $1.5607 per cubic yard; 7787 cu. yd. of concrete had been placed at an average cost of $9.2091 per cubic yard; 135,442 lin. ft. of wood piles and 3060 lin. ft. of concrete piles had been driven, at an average cost of $0.4820 and $3.2358 per linear foot, respectively. In constructing the docks 12,435 lin. ft. of concrete caissons were placed at an average cost, including excavation, of $18.4708 per linear foot.

Buildings.—There had been expended in the preparation of permanent townsites $52,458,77 and in the construction of permanent buildings $55,918.76. In the preparation of foundations for the administration building 38,073 cu. yd. of material had been excavated, at an average cost of $0.5654 per cubic yard, and 770 cu. yd. of concrete had been laid in the foundations at an average cost of $12.8646 per cubic yard.

The amount paid for salaries of clerks and supervisory forces during the fiscal year was 19.75 per cent of the total amount disbursed for salaries. Last year it was 20.55 per cent, indicating a saving in clerical and supervisory forces of about $185,000.

MATERIAL

The value of material received from the United States during the year was greater than for any preceding year; it amounted to $13,980,071, not including $2,535,860 paid to the McClintic-Marshall Construction Company or the value of local purchases on the Isthmus amounting to $2,733,867. The consumption of cement decreased from 1,600,000 bbl. in 1912 to 1,200,000 bbl. in 1913; the total consumption to date amounted to 5,797,910 bbl. During the year all cement was purchased in sacks, of which 33,475,408 were received and 29,882,968 were returned to the United States; of those returned, 269,775 sacks were rejected, or less than 1 per cent of those returned.

The consumption of lumber was approximately 27,000,000 ft., board measure, about the same as the preceding year, and the total receipts of lumber since the inception of the work have been 231,000,000 ft., board measure. The stock on hand at all storehouses on June 30 amounted to $3,436,995, a decrease of $284,217 from the stock on hand June 30, 1912. The actual reduction was greater than the net decrease would indicate, as approximately $638,000 worth of material was returned to stock by the various divisions.

CANAL FINANCES

Congress has appropriated a total of $349,505,223.14 for canal construction, including appropriations contained in the act of June 23, 1913. Of this amount, $10,676,950 were for fortifications, of which $4,870,000 were appropriated by the act of June 23, 1913, and $21,411.56 were for the relief of private persons. The balance, $338,806,861.58, including $16,265,393 appropriated by the act of June 23, 1913, was appropriated for the construction of the canal and is a charge against the total authorized bond issue of $375,200,900. This leaves available for appropriation a balance of $36,394,038.42. The actual cash balance on hand June 30, 1913, for the construction of the canal, excluding the amount available for fortifications, was $20,673,904.79. Up to June 30, 1913; $5,856,838.35 were collected and returned to the Treasury as miscellaneous receipts. This item represents the total amount appropriated by Congress which, after being used for miscellaneous purposes in connection with the canal work, was covered back into the Treasury and lost to canal appropriations.

The total amount paid out on pay rolls aggregated $20,524,705.75, in addition to which $9,035,630.18 were paid out in settlement of public bills and on reimbursement vouchers. The value of hotel books, commissary books and meal tickets issued totaled $1,305,405.

SANITATION.

The work of the department of sanitation, in charge of Col. William C. Gorgas, consists in cutting grass and brush, oiling pools, constructing and maintaining ditches for drainage purposes, removal of garbage and night soil, fumigation and street cleaning. The total expense for sanitary work in the Canal Zone and in the cities of Panama and Colon was $510,529.17.

Admissions to hospitals and sick camps during the year, including those sick in quarters, totaled 33,779; the daily average number of employees sick was 19.04 out of every thousand, as against 22.91 for 1911-12 and 24.77 for 1910-11—this on the basis that the total numbers employed during the years mentioned were 54,000, 50,008 and 49,129, respectively. The total number of deaths among employees was 483, of which 36 were Americans, 58 were white employees of other nationalities, and 389 were blacks.

WATER IN CULEBRA CUT

It has been the general belief that the effect of the water in the Cut would tend to retard slides, and the experience below the Gatun locks in the sustaining power of water against slides fully justifies this belief; on the other hand, the geologist is of the opinion that the water may to some extent develop new slides. Again, much ado was made in 1909 over the seamy character of rock on the Isthmus, through which water flows quite rapidly, in consequence of which the question was raised that the lake might leak out through seams and crevices. If these things are liable to occur, the sooner the better, if the official opening of the canal is to occur January 1, 1915; for if water were not admitted this fall but were deferred until May 1, 1914, the full height could not be reached until October, 1914, leaving little time for the determination of these questions. These considerations led to the conclusion that the water should be turned into the Cut at the earliest date for getting dredges to work on slides.

Causes of Inefficiency of Irrigation

By A. S. GIBB,
A. M. I. C. E.; Executive Engineer, Irrigation Board, Punjab, India

During the year 1911 a searching investigation of the causes which influence the economic application of water for irrigation was made on one of the large irrigation systems of the Punjab in India. The investigation included an inquiry into the effect of each of the following factors of the problem: Class of cultivator; relative area of the blocks of land served by single outlets from the canal; kind of soil; and degree of liberality of water allowance. There were two main objects in view in instituting the inquiry—first, an endeavor to trace to its source the water which is causing a rapid rise of the underground water level and threatens ultimately to waterlog the area; and, second, an attempt to ascertain what the possibilities are of reducing somewhat the supply taken by the canal so as to render some of its water available for an extension of irrigated area elsewhere.

In all about a hundred water-course systems were studied, each separately. The average discharge of water received from its outlet by each was accurately ascertained by a series of Cippoletti weir observations, and the areas irrigated by each in the last two years (four crops) were taken from the revenue assessment records of measurements made while the crops were on the ground. The quality of the crops was not taken into account, as this depends on a variety of other factors and is not directly dependent on the amount of water used. The figures were worked up in such a way as to isolate each of the above variable factors and its effect, thus enabling each to be studied separately. The results supply those concerned with efficient irrigation with matter for reflection.

CLASSES OF NATIVE IRRIGATORS

There are six different classes of native cultivators represented on the water courses observed. These range from a caste of Sikh farmers, known as being among the very best agriculturists in Northern India, to Mohammedan Janglis, who were cattle thieves by profession only fifteen or twenty years ago and are still inefficient cultivators. It was found, however, that, other things being equal, the expert Sikh cultivators were only 9 per cent more efficient as irrigators than the men with cattle-lifting traditions and education. That is, given the same water on the same land, the best class was able to irrigate only 9 per cent more area than the least efficient class. Taken as a whole, the average cultivator irrigates only 4 or 5 per cent less efficiently than the very best.

The second factor really deals with the supply in the water course—that is, the discharge actually delivered to each field in turn; but it is conveniently expressed in terms of the area of the block of land served by a single water course or outlet, assuming a constant water allowance. The absorption losses from a very small channel are relatively great; but, on the other hand, a large discharge of water is not easily controlled by the villagers with the primitive means at their disposal, so that it is to be expected that there will be an intermediate discharge which will give the most economical results. This is what the investigation has shown to be the case. Table 1 gives the results obtained after neutralizing the effect of the other influences. The efficiencies are expressed as percentages of the best.

It is shown that discharges of less than 1 or more than 2 sec.-ft. are comparatively inefficient, the best results being obtained with supplies intermediate between these figures.

TABLE 1—RELATIVE EFFICIENCY OF IRRIGATION

Area served by a single water course, acres	Corresponding discharge of water course at outlet, sec.-ft.	Relative efficiency of irrigation, per cent
Below 360	Less than 1	94
From 360 to 540	1 to 1.5	100
From 540 to 720	1.5 to 2	99
From 720 to 1000	2 to 2.5	95
Over 1000	Over 2.5	

Interesting as these results are, and though they suggest the possibility of a slight enhancement in the all-round efficiency of an irrigation system, they do not hold out the hope of any very vast improvement on existing conditions.

The investigation of the third factor, the kind of soil, does not help us, as it was found that after eliminating soils whose behavior was affected by the presence of an excess of alkaline salts the difference between the total quantity of water required to raise crops on comparatively heavy loam and on light loam is so small as to be negligible for all practical purposes. There is, of course, a difference in the way in which water should be and is applied to heavy and light soils, but the total quantity of water required, depending as it does more on the crop than on the soil, is practically the same for both.

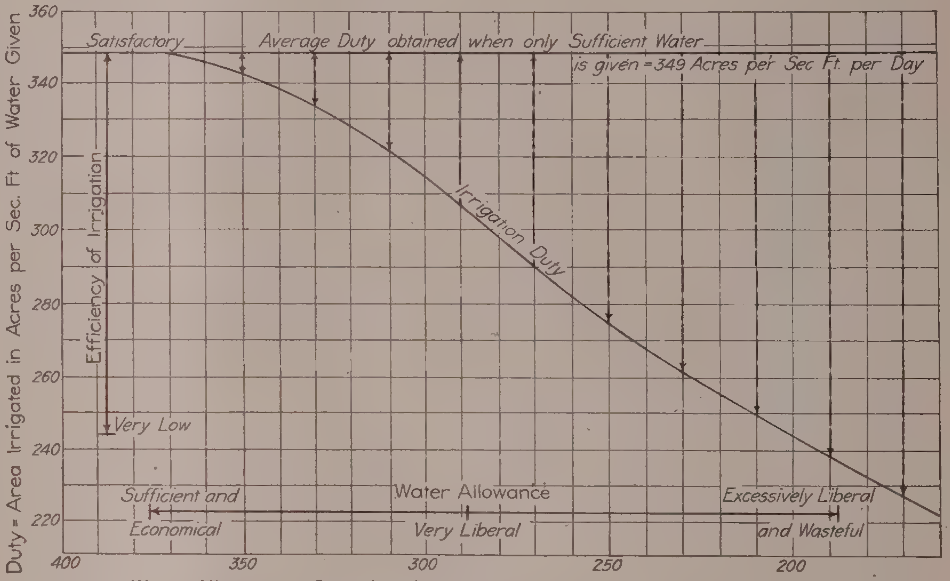


Diagram of Comparative Efficiencies of Irrigation for Various Degrees of Water Supply

Curve shows irrigation duty obtained for different water allowances. Ordinates represent area in acres irrigated annually by supply of 1 sec.-ft. Intercept of ordinates between the two curves represents areas of irrigation lost owing to excessive water allowance.

ALLOWANCES OF WATER

There remains the last factor, namely, the liberality of the allowance of water given. Water allowance is conveniently expressed in terms of the area of occupied and irrigable land for which a unit of supply is provided. The allowance of water as actually supplied was found to vary greatly among the different water courses selected for observation. In fact, with the system of distribution employed on the Punjab irrigation canals, where the outlets consist simply of masonry or metal pipes through the canal banks, it is not to be expected that the distribution of water can be otherwise than extremely inaccurate. The attached diagram and Table 2 show the result of this inaccuracy as brought to light by these investigations. In both of these the effect of the other variables has been neutralized and the area actually irrigated by the best class of cultivator with the best size of water course is taken as the standard of efficiency. Expressed in figures this standard represents annual irrigation at the rate of 349 out of every 380 acres of holding by means of 1 sec.-ft. of supply.

Table 2 is best explained by examples. Take, for instance, an outlet which serves an area of 380 acres, and ought to get a supply of 1 sec.-ft., and assume that it is actually receiving 1.3 sec.-ft.—just a trifling excess as accuracy is estimated in these matters. The result is that only 0.15 of the 0.3 sec.-ft. excess supply is used for efficient irrigation, while the other 0.15 sec.-ft., or 15 per cent of what the supply should be, is utterly wasted. Again, if the supply is 40 per cent. in excess—which very commonly occurs—then 0.24 out of the 1.40 sec.-ft. received is wasted and only as much area is irrigated as would have been done by 1.16 sec.-ft. on an occupied area of 440 acres. If double the standard supply is given, then of the 100 per cent excess of water supplied only 37 per cent does useful irrigation, while 63 per cent is wasted.

The diagram in a graphic way tells the same story as Table 2, and shows the loss caused by too liberal supplies of water in acres of irrigated land instead of in percentages.

IRRIGATION EFFICIENCY

The abscissæ represent degrees of liberality of water allowance expressed in terms of the area of occupied irrigable land for which one

TABLE 2—HOW MUCH OF THE EXCESS SUPPLY OF WATER IS USED FOR IRRIGATION AND HOW MUCH IS WASTED

	Standard attainable										
Discharge of water course at outlet, sec.-ft.	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
Percentage of excess	0	10	20	30	40	50	60	70	80	90	100
Irrigated area attainable if all the water were used efficiently, acres	349	384	419	454	489	524	558	593	628	663	698
Area actually irrigated, acres	349	374	391	400	406	415	426	439	450	464	478
Part of the excess water used for efficient irrigation	0	7	12	15	16	19	22	26	29	33	37
Part of the excess water wasted	0	3	8	15	24	31	38	44	51	57	63

unit of discharge is provided—liberality of allowance increases from left to right of the diagram. The ordinates of the curve represent annual irrigation duties or the efficiency of the irrigation expressed in terms of the area of crop actually matured annually by one unit of discharge—low efficiency is at the bottom of the diagram and high at the top. A glance at the diagram shows how seriously the efficiency of the irrigation falls off as the liberality of the water supply increases; and the influence of this factor on the all-round efficiency of the canal system is obviously of great importance.

Allowance of Water

Owing to the unsatisfactory nature of the existing outlets, the allowance of water supplied to water courses varies between very wide limits, and the variation is almost always in the direction of excessive liberality, because shortage of water produces complaints followed by an increased supply, while excess is accepted in silence by the cultivators.

Here, then, is a cause of inefficiency in the application of water for irrigation whose effect probably far exceeds that of any other cause, and which is directly responsible for the loss of more water than is caused by all the other factors put together. It is now evident where most of the water comes from which has caused the water-logging of irrigated tracts in the past and is now raising the underground water level of almost every tract in the world with such alarming rapidity; and it is also obvious that if this leakage can be stopped by the adoption of really accurate means of regulation at outlets, then large supplies can be made available for the extension of irrigation to new areas without detriment to the crops on the land already provided for.

The results of the inquiry may be summarized as follows: To check this rise of the underground water level, and to save for useful irrigation the large quantities of water at present wasted, a little can be done by educating all the cultivators up to the standard of the best, a little can also be done by subdividing the land so as to suit the most economical discharge of water course, but much can be done by increasing the accuracy with which the water is distributed to the lands of the circulators.

Good Roads in Ontario

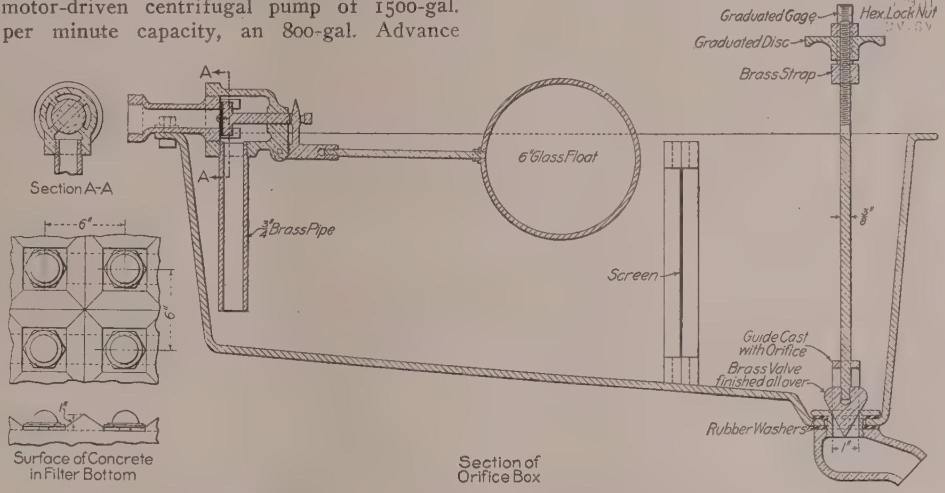
Following a report on good roads in Essex County, Ontario, Canada, in which Mr. Huber, of the Ontario Public Works Department, recommends 27 miles of macadam and 157¾ miles of concrete, the county officials have ordered an election to be held previous to Jan. 7, 1914, for the necessary bond issue. The committee and the engineer estimated the average cost of concrete roads 12 ft. wide and 7 in. thick at $1.09 to $1.20 per square yard. Before making his recommendation Mr. Huber inspected the various roads, taking notes of drainage, grades and relative convenience of getting road material on the ground. He stated that to make good macadam roads the year around a dry subgrade was essential. This was impossible of attainment except in few places. The total cost of the scheme, it is estimated, will be more than $1,100,000, but the 2 per cent tax limit permits raising only $660,000 by bond issue, so that the towns and villages will assist. Windsor and Walkerville have agreed to contribute $60,000 and $30,000 respectively, to be paid in ten yearly installments. The thirty-year county debentures bear 5 per cent interest.

Rock Island Arsenal Filter Plant

Rapid Filters Purify Mississippi River Water, Obviating Hauling of Drinking Water for Post of 1700 People

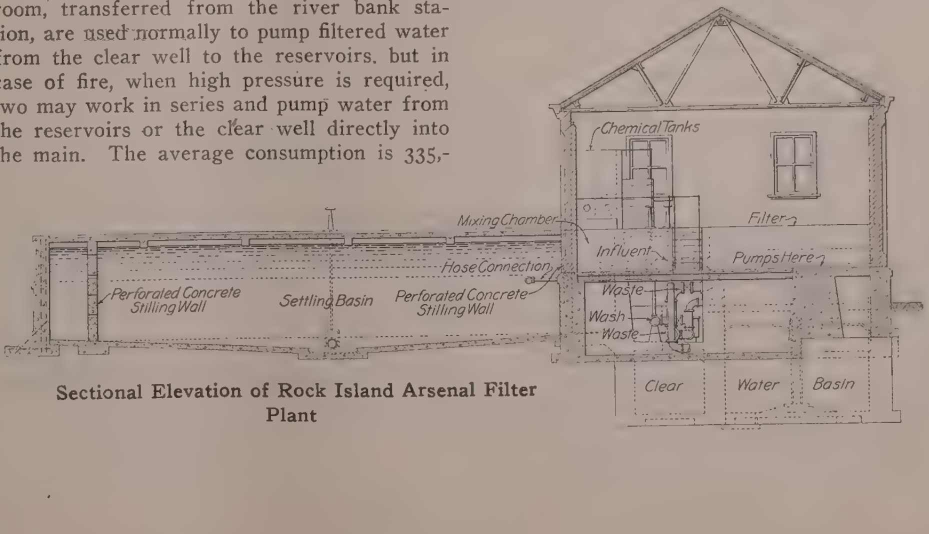
A PERFORATED concrete-baffled settling basin, three 500,000-gal. rapid-filter units, a clear well and a superstructure of brick housing the filters, machinery and chemical apparatus comprise the new water-purification works at the Rock Island Arsenal, located on an island in the Mississippi River opposite Rock Island on the Illinois side and Davenport on the Iowa shore. Approximately 200 persons reside on the island and 1500 employees work in the shops and offices. Formerly filtered water for drinking was transported at considerable expense by tank wagons from a nearby city

Pumps draw water through a 16-in. pipe, extending out into the river 460 ft. and force it to the filter plant located on a hill 1200 ft. away and about 40 ft. above the river. This station is equipped with a new Janesville motor-driven centrifugal pump of 1500-gal. per minute capacity, an 800-gal. Advance motor-driven pump, and, for emergency, a Worthington duplex steam pump of 700-gal. capacity. Formerly water was furnished to two reservoirs, of 500,000 and 100,000 gal. capacity each, near the filters. These reservoirs are now utilized to store filtered water and furnish a gravity supply to the offices, shops and residences on the island.



Section of Orifice Box and Detail of Concrete in Filter Bottom

In general layout the three filters are placed at the end of the settling basin, but are separated from it by the pipe gallery and entrance and exit chambers. Over these latter are located the chemical tanks and feeders. The clear well, which is excavated from rock, extends only under the filters, pipe gallery and chambers. Wash-water is supplied from the reservoirs. The three pumps in the filter room, transferred from the river bank station, are used normally to pump filtered water from the clear well to the reservoirs, but in case of fire, when high pressure is required, two may work in series and pump water from the reservoirs or the clear well directly into the main. The average consumption is 335,000 gal. in twenty-four hours, while the maximum day's use is 517,500 gal.



Sectional Elevation of Rock Island Arsenal Filter Plant

In effect the rectangular settling basin has a single round-the-end concrete baffle down the center of the long way of the basin, whose inside dimensions are 52 x 37 ft. in plan and 10 ft. deep to the under side of the 4-in. roof. The concrete baffle extends within 4 ft. of the end wall farthest from the filters, where a chamber 4 ft. wide is formed by a perforated concrete stilling wall having 2⅜-in. diameter holes placed on 12-in. centers, equivalent to 1.85 per cent. of the total cross-sectional area. In addition a 10 x 10-in. opening was left near the bottom of each wall to permit sluicing out of sediment. Through a similarly perforated wall the outlet to the mixing chamber and the inlet to the collecting well discharge water and receive it from the basin. These latter walls were built directly under the superstructure wall, the mixing and receiving chambers being entirely outside of the settling basin and within the main building.

Normally the water remains in the basin four hours and travels at the rate of 0.55 ft. per minute. Cleaning provisions consist of hose connections to the high pressure mains and an 18-in. tile drain laid from the center of the baffle to the river. The floor slopes toward the outlet sump, which is 15 in. lower than the outer walls.

Sulphate of alum in doses varying from 1 to 8 grains is added to the water as it enters the settling basin, although a pipe is inserted to feed into the stilling chamber at the end of the concrete baffle. Bleach is added to the water entering the filters.

The four solution tanks, two for each chemical, are each of the same size, 4 x 4 ft. in plan and 5 ft. deep, and are built of reinforced-concrete 6 and 8-in. walls. They are set up 3 ft. above the operating floor to permit a gravity discharge into the orifice boxes.

Dissolving trays or boxes 12 in. deep over the tank are built of 1-in. cypress lumber and have the bottoms bored with ¾-in. holes on 2-in. centers, covered with ⅛-in. mesh brass-wire screen.

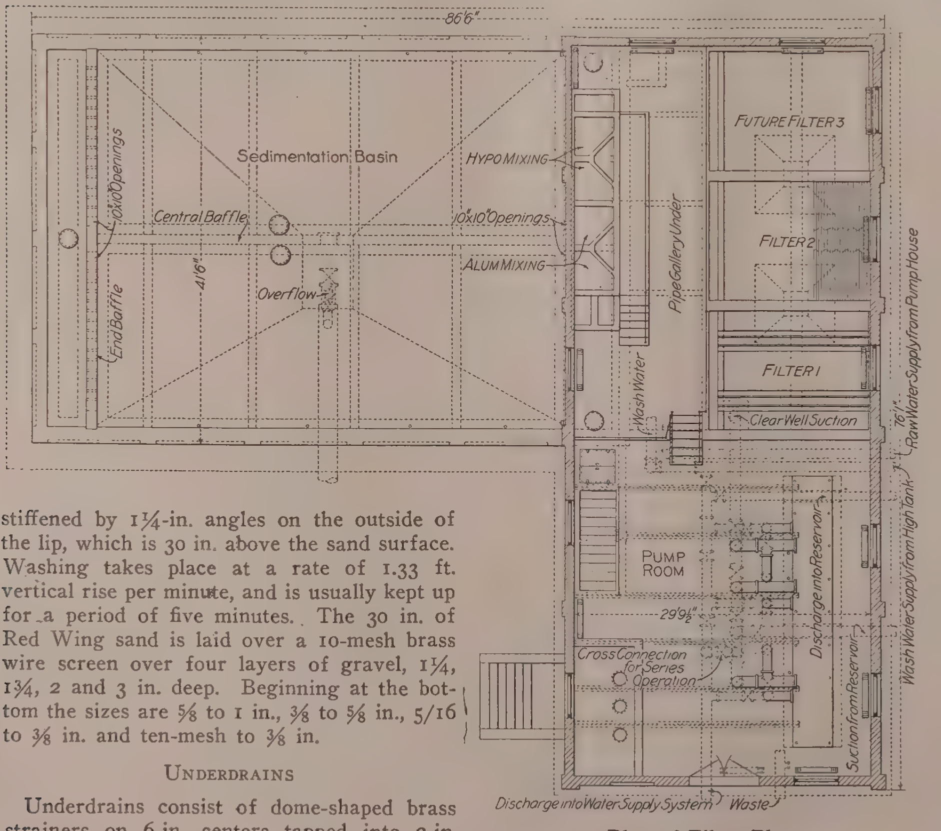
Orifice Boxes

Three porcelain enameled orifice boxes are provided, one for bleach and two for alum. The galvanized-iron piping system is interconnected so that bleach may be fed through one of the alum boxes. The boxes are 10 x 21¾ in. on the bottom, 8 in. deep at the inlet end, and 10 in. deep over the outlet. Water enters through a float valve controlled by a 6-in. glass ball and encounters a 1/16 in. mesh brass sieve before reaching the needle valve, making an annular orifice. Regulation of the opening is by means of a graduated disk, 3 in. in diameter on the upper end of the ⅜-in. valve stem. A graduated scale at the side of the disk registers the number of whole revolutions.

To determine quantities of chemicals to add, analyses are made each day by the arsenal chemist, and the rate of pumping is gaged by the rate indicators on the filters. Usually 4½ per cent solutions of coagulant and 0.13 per cent. of bleach are made up.

Only two filters so far have been equipped. They are concrete boxes 12 ft. wide and 15 ft. long to the 9-in. wall, built 18 in. in front of the pipe gallery wall to form a wash water collecting gutter. The boxes are supported on a slab and beam construction built up from piers in the clear-water well.

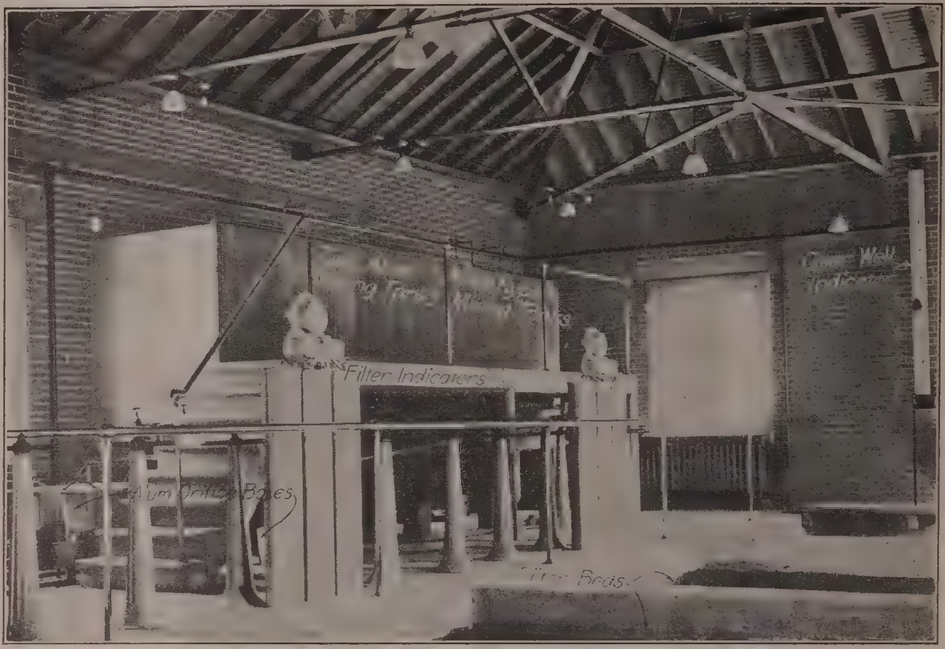
The two steel wash-water troughs in each filter have a 7-in. straight portion above the 19-in. half diameter at the bottom. They are stiffened by 1¼-in. angles on the outside of the lip, which is 30 in. above the sand surface. Washing takes place at a rate of 1.33 ft. vertical rise per minute, and is usually kept up for a period of five minutes. The 30 in. of Red Wing sand is laid over a 10-mesh brass wire screen over four layers of gravel, 1¼, 1¾, 2 and 3 in. deep. Beginning at the bottom the sizes are ⅝ to 1 in., ⅜ to ⅝ in., 5/16 to ⅜ in. and ten-mesh to ⅜ in.



Plan of Filter Plant

Underdrains

Underdrains consist of dome-shaped brass strainers on 6-in. centers tapped into 2-in. cast-iron laterals on 6-in. centers leaded into a single 10-in. manifold laid down the center of the filter. The openings in the strainers are 1/16 in. in diameter and aggregate 0.29 per cent of the total area of the filter. Concrete is filled in to the top of the laterals and ridged up both ways between the strainers to a height of 1 in.



Operating Floor, Showing Hypochlorite and Alum Tanks

Control is effected by Simplex rate controllers, from which wires lead to indicating and recording gages on the operating platform. The loss-of-head gage and these two rate gages are set in a cluster on top of the loss-of-head float tubes. The valves are manually operated from separate stands on the operating floor.

Once each month samples are sent to the Illinois State Water Survey for analysis. On March 29 the raw and filtered water showed: Turbidity, 450 and 0; color, 85 and 0; bacteria on gelatine, 5600 and 10 per cubic centimeter, and on agar, 400 and 3; gas formers were found in 10 and 1 cu. cm. in the river and none in the same quantities of the filtered water.

Wash water averages about 3 per cent of the filtered water, the filter runs ranging from eight to eleven hours on weekdays and about four hours on Sundays and holidays.

The plant is cared for by one filter man, eight hours per day, and three pump men, who are on duty to care for the existing pumping station twenty-four hours per day.

Design and construction of the filter plant and improvements to the water service were under the immediate supervision of Lieut.-Col. George W. Burr, Ordnance Department, U. S. A. The Pitt Construction Company, of Pittsburgh, was the contractor, for whom Mr. Patton was resident engineer.

Panama Lock Gates Completed

The erection of the Panama Canal lock gates was completed Oct. 30, when the last leaf was lowered to place on the hinge pintle. This was in one of the lower operating gates at the Miraflores Locks and was the largest of the ninety-two leaves built and erected by the McClintic-Marshall Company, of Pittsburgh. It was 82 ft. high and weighed more than 700 tons. Except for a small amount of adjusting, testing and painting, its completion virtually finishes the contract for fabricating and erecting about 58,000 tons of steel.

Blasting Pole-Holes in Frozen Ground has proved more economical than hand digging to the Marion Light & Heating Company, of Marion, Ind. Whenever the ground is frozen to a greater depth than 2 ft. this company digs the hole, exact size, about 15 in. deep only. With a long-handled auger a hole large enough to admit a stick of dynamite is bored about 30 in. deep. It has been found that three-quarters of a stick of dynamite will excavate a uniform hole to the desired depth of 5 ft. An average saving of 15 to 20 per cent over the cost of manual digging has justified this method.

Port Organization and Development—Part II

Discussion of the Various Systems in Vogue and Argument for Commissions Representative of the Numerous Interests Involved

The essentials required of a body to manage a port successfully are an intimate knowledge of all the ramifications of its trade, a close and ready intercourse with those engaged in it, and the confidence of the public in its management, so that when funds have to be subscribed there is a ready response to the invitation and an abundance of money available at a reasonable rate. Such a body, too, should be accessible by the commercial public, and should be susceptible to reasonable public criticism. Under an efficient system there ought to be close and intimate connection and sympathy between the management and the whole commercial interests of the port, and ready interchange of ideas and opinions upon questions affecting all sections of the community.

It is difficult to see how such a desirable condition of affairs can obtain under Government control. The responsible authorities in this case are remote from those whose interests are involved. They are concerned with national issues of far greater political importance; they are subject to political and partisan influences; they cannot be personally acquainted with the particulars of the issues involved; they are pledged to economy, and have superabundant calls upon the revenues at their disposal; they have a multitude of measures to consider, and cannot devote the attention necessary properly to appreciate the relative importance of the various claims made upon them. Furthermore, the whole procedure of introducing and obtaining authorization for new projects must be rendered tedious and laborious in the extreme, and must tend to destroy local initiative and energy.

Essentials for Port Authorities

The adoption of a constitution and organization for a dock or harbor authority on lines which will give the utmost possible opportunity for the full appreciation of all the elements contained in the complicated problem of port management and development seems of paramount importance. One essential to the fulfilment of this principle is that the authority should be in as intimate connection as possible with the trade of the port, and another is that he should have a considerable financial interest in its development and advancement.

It is assumed that the type of man available for election to the authority is such as to guarantee successful management. Most of the large ports of the country are centers of great commercial industry, and therefore men of high commercial status are available.

The second essential, that of financial interest, raises a more difficult point. It is not a necessary qualification for service on a harbor board that an individual should be an owner of bonds or stock in the concern. The majority of the representatives should, however, be so concerned in the success of the undertaking that the advancement or failure of their own business is more or less dependent upon the prosperity attained by the port.

Systems Managed by Commissions

The most prominent dock undertakings in the United Kingdom so constituted are London, Liverpool, Newcastle and Shields, Glasgow, Leith, Dublin, Belfast and Swansea. Between them they are responsible for traffic of 63,000,000 tons, representing 40 per cent of the total sea-borne traffic of the kingdom.

The Mersey Docks and Harbor Board consists of twenty-eight members, of whom twenty-four are elected by the payers of dock rates and dues. The other four members are appointed by the Conservancy Commissioners of the River Mersey, who are the First Lord of the Admiralty, the President of the Board of Trade and the Chancellor of the Duchy of Lancaster. All members are elected for five years, and after that time are bound to retire, but may offer themselves again for election. In a large port and commercial city like Liverpool, which is the center of many wealthy and vigorous trades, these latter are formed into different representative associations, such as the Shipowners' Association, the Cotton Trade Association, the Grain Trade Association and many others, and the members of all these associations are qualified voters for the election of members of the board. There is a tacit understanding among all these associations that they shall respectively have a certain number of representatives on the board.

Conservation of Estuaries

Schemes of general river improvement are almost always attended with greater difficulties in their promotion and sanction than any other form of dock or port enterprise. The interests are so diverse, and the benefits to be achieved vary so greatly in character, that it is extremely difficult to obtain unanimous acquiescence in any large project. Additional difficulties are imposed by the rivalry between competitive interests in the same waterway, and one interest will strenuously oppose an improvement which it considers to be promoted for the benefit of a rival without corresponding advantage to itself, and to which it or its clients will have to contribute.

Chief among this class of difficulty is the old-standing antagonism between the interests situated up river and those near the sea. The promotion of a scheme of improvement for the upper part of the river does not generally commend itself to those near the mouth. Vice versa, projects for improvement of the bars and lower reaches of the river frequently meet with hostility from the up-river interests. Of recent years the view taken of such schemes has been so critical and sectional in its character that division of opinion has even arisen between the owners of vessels of various classes, owners of small vessels objecting to taxation for improvements which they have deemed to be carried out solely in the interests of the large ships.

As regards such antagonism between upper and lower river interests, any scheme comprehensively sound that is designed to benefit physically a section of the river cannot but improve the régime of the whole river. In the case of acute rivalries between various dock or ship owners situated on the same estuary, therefore, the disinterestedness and impartiality of a conservancy board such as that of the River Mersey is very desirable.

Another point which may arise in connection with the conservation of river estuaries is the diversion for purposes of water supply to some large town or district of a portion of the head waters of the river. This is a serious matter from the point of view of the maintenance of the river for navigation purposes and still more so of its improvement. The diversion of any serious proportion of the head waters affects the régime of the river to a much greater extent than is represented by the simple ratio of the quantity diverted to the whole volume. It is therefore certainly most desirable that all the surroundings of such propositions should be most carefully investigated, and the alternatives examined, with a view to avoiding, if possible, so serious a risk to the interests of the river and those of the industrial populations which may be largely dependent on the due preservation of the navigation and trade interests.

Observations and Records

The science of river hydraulics is one of the most difficult that the port and docks engineer encounters. The variations in the conditions surrounding different rivers, the paucity of data, the obscurity of many of the phenomena, the complexity of the forces at work, particularly in tidal rivers, and the difficulty which arises so often in distinguishing between cause and effect, all make the consideration of the problems involved in the examination and treatment of rivers a very difficult matter, in which the engineer has often to rely chiefly upon experience and judgment. Conservancy boards can, however, render great service to this particular branch of engineering by collecting and recording all the information available on their respective charges.

Periodical surveys at regular intervals, tidal observations throughout the tidal range, the relative effects of spring and neap tides and storms on the off-lying banks at the mouth of the river, current observations, the effect of land floods and of dry and wet seasons; the observation of any important changes in bars, shoals, banks or channels, and the connection between these changes and any special physical phenomena at work, synchronous or otherwise; the effect of acute bends in river courses and the absorption of potential which they involve; the establishment, if possible, of a law defining the correct sectional areas for the tidal portion of the river, are all most important matters for systematic observation, records and determination. A well-established and well-conducted conservancy has a great field of research and work in the collecting and recording of all such data and information which, in the hands of a competent engineer, will be of priceless value in considering any schemes that may be put forward. The estuary that has been watched, surveyed and studied will certainly be treated with much less risk of failure or waste of money than one where such information is not available. A conservancy board should allocate a sufficient sum annually for such observations and records which ought to be made public.

Importance of Conservancy Board

It will be apparent from the foregoing as to the organization and duties of a conservancy board that its constitution and relationship to the local dock and harbor authorities with which it comes in contact play an important part in the determination of its utility, and that the more independent it is, on the one hand, and the more generally, on the other hand, the powers of dock provision and management are vested in one authority, the more simplified and satisfactory are the negotiations and operations of both corporations likely to be, and the less chance will there be of disagreements and obstruction arising in connection with any scheme put forward by either.

It would be difficult to exaggerate the importance of the relations of railway and other interests to the port, for their successful establishment and conduct most materially affect its working. The railways, waterways and cartage systems bear the same relation to the collection and distribution of the port traffic in the interior of the country as the ships traversing the ocean do to the international interchange of its commerce. The relative facilities in despatch and economy attendant on the collection and shipment of goods for the purposes of export, and the discharge and distribution of imports, go a long way in the determination of the choice of trade routes, so that it is essential that these operations should be arranged on as satisfactory a basis in all respects as is possible.

An old port which has been laid out under totally different circumstances to meet old-fashioned requirements frequently finds itself in the position of having to abandon its former methods and adopt others better suited to modern requirements. Changes of this character involve not only important physical alterations necessitating considerable outlay of money, but, what is of greater importance, frequently necessitate interference with existing interests and industries, giving rise to much opposition and obstruction to the introduction of the change.

Port of New York

The want of an influential and independent body is apparently being felt very seriously at the present time at the port of New York. Here the management of the docks or wharves was formerly vested in the municipal authority, but has been recently handed over to the Board of Estimate and Apportionment, with a dock commissioner appointed by the Mayor.

A serious issue has arisen, in connection with the construction of new wharves, as to how the railway connections are to be established, and in what authority their ownership and control is to be vested. This question has excited much discussion by those interested in the welfare of the port. There is strong opposition to the railway companies being allowed to get control of these connections, on the ground that they would not be used to the full advantage of the port, but rather to promote railway interests alone.

Were there in this case a strong independent body representing general trade interests, no doubt the rivalries and difficulties which have arisen between the railway and port interests would disappear in the confidence which would be felt that both would receive their fair consideration at the hands of a trust, with no private interests to serve, and concerned only in promoting the general welfare of the port, and with it that of all its auxiliaries.

The tendency in the United States and Canada seems to be toward the establishment of small commissions or trusts consisting of three or four independent people who control and manage the ports. The governing bodies at New York, Boston and Montreal are all constituted on those lines.

Other Advantages of Commissions

In one further and very important respect it may be stated that a public trust, such as the Mersey Docks and Harbor Board, has the great advantage over a company that whenever it comes before Parliament to promote a new scheme, and generally in all its transactions with public authorities and officials, it occupies such a disinterested and representative position that it would require very powerful and clearly demonstrated objections to upset any proposals it may put forward in the interests of trade. Moreover, the fact that it is a statutory authority, constituted for the very purpose of developing the port in accordance with trade requirements, gives it a strong claim on the good will and assistance of Parliament, as well as of all government departments and officials, and reduces to a minimum the chance of successful opposition to its proposals.

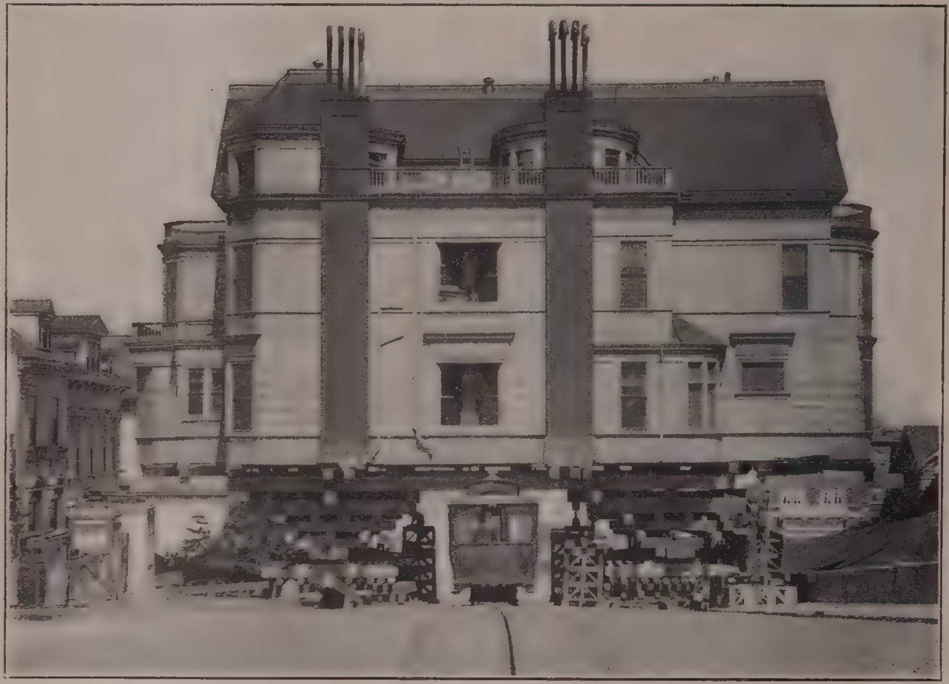
One further and extremely important advantage which emphasizes the disinterestedness and adds to the value of such a constitution as a public trust, may be quoted—its method of borrowing money. In the case of the Mersey Docks and Harbor Board money is raised at fixed rates on bonds running for short periods, or on stock redeemable within sixty years. There are no shareholders, and consequently there is no tendency to tax unduly trade for their benefit. All revenues are devoted to meeting working expenses, insurance accounts and liabilities for interest on bonds, and any surplus after making due provision for depreciation is, in the main, allocated to the reduction of rates, so that the traders feel that, presuming the finances of the board are wisely administered, they obtain the accommodation afforded and the services rendered at a minimum of cost. Nor is this power of reducing the rates merely nominal. In the course of the last thirty years the Mersey Docks and Harbor Board has given large reductions in rates to the traders as circumstances justified such action, so that the traders have realized in this respect the benefit of the co-operative principle. On the other hand, the board has wisely spent considerable sums from its revenues in the improvement and betterment of its estate, thus increasing its earning capacity and reducing the increased capital indebtedness which would result from the converse policy of borrowing fresh sums for all such purposes. As such expenditure is generally effected on improvements which afford a quick return for the outlay, the benefit from it is rapidly realized, and so is early profitable to the payers of rates and dues.

Railroad Operating Revenue for July on the large steam roads of the United States, as given in a bulletin issued by the Interstate Commerce Commission, amounted to $260,675,397.13, an increase of $13,364,380.39 over July, 1912; operating expenses were $182,662,583.97, an increase of $15,942,385.69; and net operating revenue was $78,012,813.16, a decrease of $2,578,005.30. The operating ratio increased from 67.41 to 70.07 per cent.

Move House over Street Cars in Operation

San Francisco Residence, Transferred to New Site, Is Jacked Up to Bridge Traffic

The accompanying photograph shows how a large house was moved along a narrow street without blockading street-car or vehicle traffic. The house is a private residence which was moved from its location on Washington Street between Octavia and Gough Streets, San Francisco, to a new site in the adjoining block. The width of the street along which the house was carried is 68 ft. 9 in. between property lines and 38 ft. 9 in. between curb lines. A single-track cable-car line runs along the center of the street, and the width of the house was too great to permit of its being moved longitudinally along either side of the street at ground level without obstructing the car track. The street railway company objected to any interference with its service, so the contractor resorted to the expedient of jacking the structure to a sufficient height to permit cars to pass beneath it. Cribwork was then placed on the skids to support the house in the position shown, and moving operations were performed in the ordinary way. In this manner the house was moved down a 16½ per cent grade.



House Being Moved without Blocking Traffic of Street-Railway Cars

The Massachusetts Traffic Census for 1912 shows that, for the roads observed, the total traffic increased 42 per cent since 1909. Horse-drawn vehicles decreased 14 per cent, but motor cars increased 131 per cent. A significant feature, showing the increasing demands of traffic, is found in the statement that heavy teams showed a slight decrease only, while light horse vehicles were diminishing rapidly. Motor trucks, practically non-existent three years before, constituted 3 per cent of the total in 1912. The great increase in this class of traffic prompted the highway commission to recommend the use of 18-ft. roadways on all main routes, with a top layer of 3 in. of bituminous macadam. It is proposed in the future to charge motor trucks on the same basis as pleasure cars.

Railways and Subways at Buenos Aires

Transportation Facilities in Argentine Capital and Underground Routes Being Built to Serve City and Unite Main Terminals

By F. LAVIS
M. Am. Soc. C. E.; Consulting Engineer, New York City

BUENOS AIRES, the capital of the Argentine Republic, is a city of about 1,250,000 inhabitants, and besides being the seat of government it is the commercial center of the country. The Government House is practically the center of the business and political life of the city, and from the front of it the Avenida de Mayo leads, in a direction perpendicular to the river, to the Halls of Congress. This wide avenue was made by razing about half a block along one side of the old narrow street, and may be considered the main axis of the city. Immediately in front of the Government House is the Plaza de Mayo, which occupies two whole blocks, and in front of the new Congressional Building three blocks of houses were demolished to provide a plaza and proper setting for the marble building which, although occupied, is not yet completed.

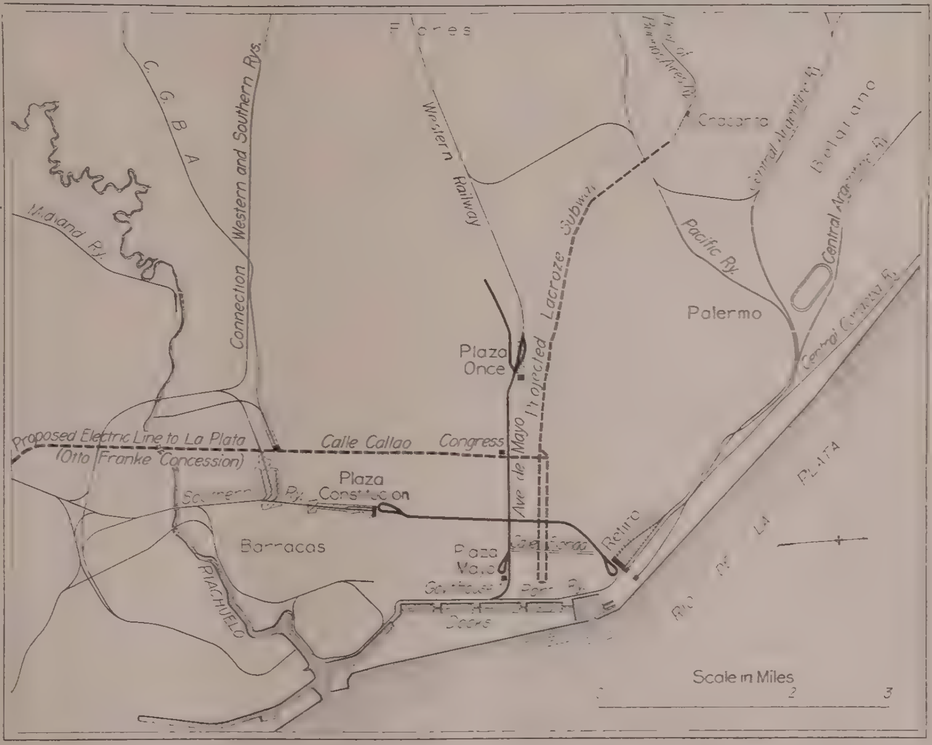
Arrangement of Streets

In the business section the streets are narrow—about 33 ft. wide—and very much congested, and through nearly all of them the traffic is allowed to go in only one direction. There are tram lines in practically all of the streets in the built-up and thicky populated section and they are placed on the side next to the lefthand curb. On the Calle Florida, the center of the fashionable retail shopping district, all vehicular traffic is suspended in the afternoon, and the whole street given over to pedestrians, who at certain hours seem to fill it completely.

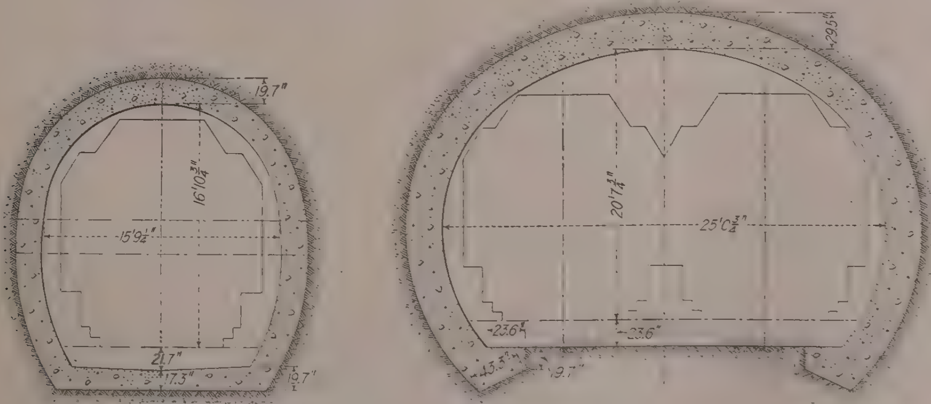
The streets are in general laid out on the rectangular plan and are named instead of numbered. The numbers of the houses in the streets parallel to the Avenida de Mayo run from 0 at the river and increase 100 each block. On the cross streets the numbers start at 0 at the Avenida and run both ways, different names being given to the streets on either side of it, although their alignment may be continuous. Two new avenues, running diagonally southeast and southwest from the Plaza Mayo, have been projected and their construction started. Although this improvement is urgently needed the expense will be very large, as the avenues cut directly through a great deal of very expensive property.

Topography

The general topography of the city is flat. There is a bank or "baranca" from 30 to 60 ft. in height which runs more or less parallel to the river and was once along the edge of it. The land for a considerable width along the foot of the bank has now, however, been reclaimed and filled in, and here are located the docks and shipping interests. From the top of the bank the ground is very gently rolling and remains at practically the same elevation over the whole area of the city, except toward its southern boundary, where there is a section of more or less low land bordering the Riachuelo, a creek tributary to the Rio de la Plata, along the lower banks of which much of the bulk-freight shipping is established. From the Plaza Mayo or Government House southerly to the Southern Railway Terminal are located most of the wholesale houses. Beyond the terminal and along the Riachuelo are the "barracas" or warehouses for deposits of coal, lumber and all kinds of bulk merchandise.



Map Showing Railroad Lines and Terminals and Subway Projects



Typical Cross-Sections of Single-Track and Double-Track Tunnels

Immediately north of the Plaza Mayo is the financial district, and north and west of this the retail shopping district, this latter reaching nearly to Retiro and extending some ten blocks back from the river. The best residential district is generally west and north from Retiro, but the whole of the area shown on the general map is densely populated. There are no real skyscrapers in the business district, but there are several buildings of the steel-frame type from ten to twelve stories in height which will compare favorably, from both an architectural and an utilitarian standpoint, with those in any modern city.

Railroads

The Southern Railway, which has its terminus at the Plaza Constitucion, reaches all the southern section of the Province of Buenos Aires and is about the largest and richest of all the railways of the Argentine. The Western Railway, occupying the center of the province and the zone immediately north of the Southern, has its terminus at Plaza Once. These two roads have a combined length of about 5000 miles, with annual gross earnings of nearly $40,000,000 gold. The northern roads all have their terminals at Retiro. They are the Central Argentine and the Buenos Aires Pacific, both broad gage (5 ft. 6 in.), and the Central Cordoba, meter gage. The terminal of the latter is used for connections to the government lines and the Province of Santa Fé Railways. The combined length of all the lines reaching the three terminals at Retiro, either directly or through connections, is nearly 10,000 miles. The very important system of standard-gage railways reaching Paraguay through the Provinces of Entre Rios and Corrientes now enters the city over the lines of the Central of Buenos Aires Railway at Chacarita. It is expected, however, that they will eventually be brought into the Central Cordoba station at Retiro, adding another 1500 miles to the lines terminating at this point.

Suburban traffic is quite important, as may be judged from the fact that there are about 175 trains in each direction daily to and from the

Two Views Indicating the Unusual Character of the Material Encountered in the Buenos Aires Subways

Southern Railway terminal, about sixty each way on the Western Railway and more than 200 to and from the three stations at Retiro. There are several surface tram lines which reach the suburbs; some are extensions of the two principal companies serving the city and others are independent lines.

In addition to the electrification of the Western Railway the Central Argentine Railway has under consideration plans for the electrification of its suburban lines between Buenos Aires and Tigre, a popular boating station and summer resort on the river about 20 miles to the north.

Local Transportation

Buenos Aires, in common with all the large and rapidly growing cities of the world, finds it difficult to keep pace with the demand for necessary improvements, and the congestion of traffic in the streets and of shipping in the port adds greatly to the cost of doing business. The city is mainly served by two tramway companies, both using electric traction, taking the current from an overhead wire. Service is in general very good; the fare is equivalent to about 4½ cents American gold. The system of numbered routes is used and seems to work well. The rule that no more than five persons in excess of the seating capacity may be carried is generally enforced.

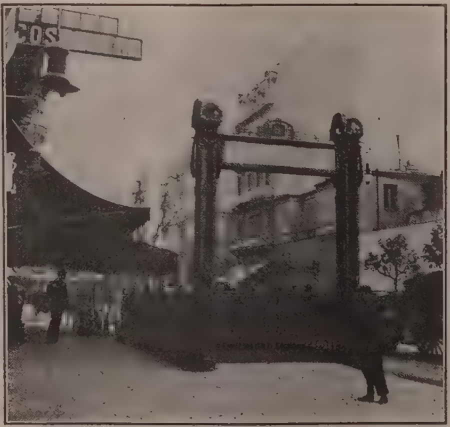
There are many horse-drawn carriages of the cabriolet type, called "coches," practically all having taximeters starting at about 25 cents gold. These vehicles are very convenient and are largely used. There are also a few taximeter motor cabs. The bulk of the passenger traffic is between the financial center and the retail store district just northwest of the Government House and all points in a semicircular district to the south, west and north, the river being on the east.

Subways

The Anglo-Argentine Tramways Company, which operates all over the city and is by far the larger of the two tramway companies, is owned and managed principally by Germans. For about two years this company has been constructing a subway between the Plaza Once and the Plaza de Mayo. This has been built mostly in open cut, the roof being near the surface. The design is the usual type of steel-frame and concrete construction. It is double-tracked and will have a loop at the lower end under the Plaza de Mayo and a connection at Calles Piedras and Chacabuco, four blocks west of the Government House, with the east-and-west subway between Retiro (the Northern Railway terminal) and the Plaza Constitucion (the Southern Railway terminal). The combined length of these two subways will be nearly 5 miles. Stations have been located three or four blocks apart throughout the lower section. An entrance to one of them in the Avenida is shown in one of the illustrations.

The section under the Avenida de Mayo, between the Government House and the Hall of Congress, a distance of nearly 1½ miles, is practically completed, and the upper section, between the latter point and the Plaza Once, also 1½ miles in length, is well underway. Under the Plaza Once is being built a union station, to be used jointly by the Anglo-Argentine trams and the Western Railway; the cars will come to the surface a mile or so to the north of this point, in the Calle Rivadavia.

The north-and-south subway from Retiro to Plaza Constitucion has not yet been started, but probably will be in the near future. This line will cross the Avenida at Calles Piedras and Chacabuco with a single track in each on account of the narrowness of the streets. It will be located beneath the present subway and over the Western Railway tunnel, which is depressed sufficiently at the point of crossing. At Calle Callao, in front of the Congressional building, the Western Railway tunnel is depressed and the present subway raised to allow another proposed north-and-south subway line to pass between them. This is for the so-called Otto Franke concession for an electric interurban line which, it is proposed, will follow under the Calle Entre Rios the continuation of Calle Callao to the other side of the Riachuelo, and thence to La Plata, the capital of the Province of Buenos Aires.



Entrance to One of the Stations

Construction Methods

Most of the construction has been in open cut, and steam shovels of German make have been used to advantage. On the Avenida about three blocks were usually opened at a time; the work was pushed most energetically and brought to a speedy conclusion once it was started. There has been general commendation of the energy and efficiency with which the work was done, and little real annoyance is caused to the abutters and the users of the streets. A complete block length was generally entirely finished and a new asphalt surface laid in less than three months from the time the street was first opened up.

The material penetrated, after passing through a top surface of loam and earth varying from nothing to perhaps 8 or 10 ft., is what is known as "tosca." This is a sort of indurated clay, often as hard as soft rock, which underlies practically the whole of the Argentine plains. The illustrations show how well the material stands up in the excavation of the tunnel and its character in front of the shovel. In one instance, where the tunnel of the Western Railway was excavated for the full section directly underneath the subway with only about 40 in. of cover, the steam shovel was worked in the subway excavation overhead without in the least disturbing the unsupported roof of the tunnel. The excavated material was loaded in standard-gage dump cars, which reached the surface by inclines conveniently located and connected to the tramways, over which they were hauled by electric traction to the disposal grounds.

Other Subway Projects

The other tramway system, the "Lacroze," is owned by the heirs of the late Frederico Lacroze, a native of the city, and operated in connection with the Central of Buenos Aires Railway, which is owned by the same interests. In a general way this system connects the terminus of the Central of Buenos Aires Railway at Chacarita with the rest of the city, the principal lines running directly toward the river and to the other railway terminals. It is proposed to build a subway, for which a concession has been granted, from Chacarita station to the port, utilizing two streets—one track in each—some five or six blocks north of the present subway in the Avenida de Mayo. It is understood that no definite plans for prosecuting this work have been made as yet.

The Western Railway, one of the four large roads controlled by British interests, decided several years ago to build a direct connection with the port railways, and for this purpose has planned a freight tunnel from its terminus at the Plaza Once to the port. This will be a single-track, horseshoe-shaped tunnel of the section shown, about 2.7 miles in length. The concrete lining of the single-track tunnels is normally 19.7 in. thick, this being increased 20 per cent or even 40 per cent in special cases; the concrete lining of the double-track tunnel is uniformly 29.5 in., as shown.

This tunnel line will leave the main line of the railroad at a point about 3000 ft. from the terminus on the north side of the line, drop under the yard tracks, pass under the Plaza Once station of the Anglo-Argentine Tramways Company and thence follow under the subway all the way to the port. For most of the distance the tunnel will be at some distance below the subway, and no difficulty is anticipated in doing the excavation or building it under the completed subway. At one or two points where the two are very close together the excavation of the lower tunnel has been made and the floor of the subway built over it.

Electrification of Railroads

The Western Railway contemplates eliminating all existing grade crossings and electrifying its suburban zone for a distance of about 25 miles from the terminal, the first half of the distance being four-tracked. It is expected to use direct current distributed through a third rail. A direct connection is to be made to the interchange station of the Anglo-Argentine Tramways Company to be built under the Plaza Once. This station will have three sets of double tracks, with two island platforms between, the middle set being used by the Western Railway. Passengers will walk across the adjacent platforms to and from the cars of the Anglo-Argentine company, which will carry them downtown and to their destination in the city.

As the gage of the Western Railway is 5 ft. 6 in. and that of the tramway company 4 ft. 8½ in., no direct through working of cars is possible. The interchange will, however, be simple and direct. The connection to the interchange station from the Western Railway will be a double-track tunnel, the approach to which starts at about the same place as the approach to the single-track freight tunnel, but on the opposite or south side of the track and near the throat of the terminal yard. A cross-section of this tunnel is shown on page 613.

The cost of excavation in these subways and tunnels is approximately $3 per cubic yard and that for concrete in place about $15 per cubic yard. The latter is very expensive, as the costs of stone, cement and labor are all very high and the cost of excavation is somewhat increased by costs of disposal. The design and construction of the tunnels of the Western Railway has been and is under the supervision of Mr. William Lowe Brown, formerly a resident engineer on the North River division of the Pennsylvania Railroad New York Tunnels. The work is being carried out by Walker Brothers, of London, England.

Hewed and Rough Timber in Railroad Construction

Cost, Data and Other Information Pertaining to Crib and Trestle Work on a Sidehill Line for Temporary Service

An example of the extent to which rough timber can sometimes be used in the construction of railroad spurs or temporary lines is given in the recently completed extension of the Ruskin-Stave Falls line in British Columbia. About 230,000 ft. b. m. of hewed and rough timber were used in crib and trestle work on this extension, which is 3300 ft. long and cost about $20,000. It was built for hauling cement and other materials to the top of the present intake dam of the Western Canada Power Company, where extensive alterations are contemplated.

The line follows along a very steep sidehill in loose, sliding earth and required a large amount of retaining-wall construction. The heavy timber growth was, therefore, utilized to good advantage, and cribs and trestles were built from cedar timber cut on the right-of-way or adjacent thereto. The cribs were built up as the grading work progressed, and in some of the longer and steeper slopes it was found convenient to terrace them in one or more sections. Several trestles were required at ravine crossings; and in order to give greater stability to these structures, timber crib foundations were built wherever the footings came on sloping ground. The road is of standard gage and was built on a uniform grade of 5 per cent, compensated, with a maximum curvature of 15 deg.

A typical trestle on crib foundation is shown in one of the illustrations. The timber in this trestle totals 59,000 ft. b. m. Including engineering supervision, the structure cost $975.75. The amount of timber used in this trestle, if bought from the mill as dimension lumber at the regular rate of $20 per 1000 ft. b. m. would have come to $1180, while a probable additional cost of $650 for erecting would have brought the total up to about twice the amount actually expended on the structure.

The timber crib shown in the other illustration contains 41,000 ft. b. m., and cost in place $970, or about $24 per 1000 ft. b. m. This cost is considered somewhat higher than the average on the work, due to the very soft earth encountered at this point. In making a fill near the lower end of the line a rough-timber trestle 600 ft. in length, with an average height of 28 ft. and a maximum height of 32 ft., was built at a cost of $2 per foot, including ties and 56-lb. rails. This structure was only used until the fill was graded for permanent roadbed, and its heaviest loading was a 12-ton dinkey engine with three 6-ton (loaded) dump cars.

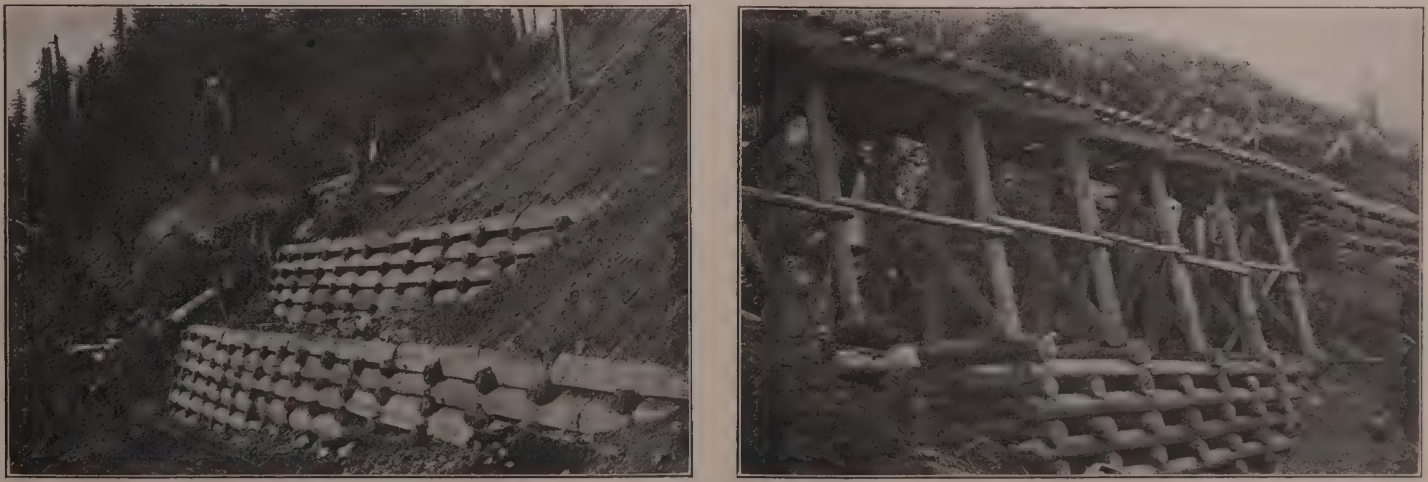
The extension of the Ruskin-Stave Falls line is being made by day labor by the Western Canada Power Company under the direction of Mr. R. F. Hayward, chief engineer, and the personal supervision of Mr. J. F. Cahan, construction engineer.

Concrete Supports for Aerial Tramways

Although in most cases steel or wooden towers are most convenient and economical for the support of cables for aerial tramways, occasions have arisen when dumping of hot ashes and slag from the buckets has threatened the safety of such structures. On this account, and in other cases to remove the pressure of the dumped material from the towers, different forms of concrete supports have been used by Bleicherts Aerial Transporters Company, of London.

An aerial cableway installed for a sugar factory in Bohemia has the cables carried on horizontal steel girders supported by pairs of comparatively short steel bents on top of cylindrical piers, built of brick or concrete blocks, with sufficient stability to permit the piling of material against them.

The cables for the tramway of a Portland cement factory in Holderbank-Wildegg are carried on reinforced-concrete poles of a rectangular cross-section, with horizontal crossarms at the top. Longer and lighter horizontal arms about midway between the surface of the ground and the main cable serve to carry special sheaves and steel braces.



Typical Cedar Crib and Trestle Construction on the Ruskin-Stave Falls Line in British Columbia

Circular Concrete Reservoir at Muskogee

Design of Muskogee Concrete Reservoir

Abstract of Paper Prepared for the American Waterworks Association by Alexander Potter, Consulting Engineer, New York

MUSKOGEE, OKLA., takes its water supply from the Grand River. The present intake is located in the channel of the Grand River, about 1800 ft. above its confluence with the Arkansas River. The extensive improvements to the water system, begun in 1910, included the construction of the 6,000,000-gal. reservoir. with which this paper deals.

The pressure in the central portion of the city ranges from 60 to 70 lb. A reservoir with its average water level at the elevation of the surface of the ground on the site at Agency Hill would give a static pressure of only 69.4 lb. over the central portion of the city. It was decided to adopt some type of construction that would insure a normal water level in the reservoir at least 20 ft. above the ground surface.

Alternative Types

A circular, reinforced-concrete reservoir was decided upon. This shape is usually the most economical, and under the existing conditions it is unquestionably so. To obtain the required capacity of 6,000,000 gal. a circular tank with its diameter limited to 200 ft. requires a depth of 26 ft. To construct a circular tank of these dimensions, in which the internal pressure is resisted by the tension in the shell, was considered inadvisable—(1) because of the high cost of construction and (2) because of the probability of structural defects developing at the junction of the shell and the bottom.

A circular reservoir 200 ft. in diameter will, when filled with water, expand 0.96 in. on the assumption that the steel in the shell is stressed to 12,000 lb. per square inch. This enlarging of the cylindrical shell, as it affects its connection to the bottom of the tank, can be taken care of in one of several ways, all of which are more or less unsatisfactory.

Reasons for Selection

All of the methods for overcoming the weakness at the connection of the bottom to the cylindrical shell are more or less experimental in a large reservoir. The amount of circumferential steel reinforcement required in the circular type also increases with the square of the diameter. Therefore, the economy in the cost of construction found in the smaller tanks no longer obtains in the larger sizes.

Another type of construction for the side walls of large reinforced-concrete tanks is the cantilever section. This type of construction is not adapted to tanks deeper than 15 ft.

Still another method, and one which has been in general use, is that in which the side walls are supported by buttresses or counterforts. This method of supporting the wall sections is a very economical one for tanks of considerable size in which the depth exceeds 8 or 10 ft. A modified type of this construction, in which the deck is inclined and supported by buttresses, is a very economical one for tanks of greater depth and is the one that was adopted for the Agency Hill reservoir. The latter type of construction is not adapted to rectangular tanks of considerable depths, where the corners are very apt to give trouble. The pressures are at right angles to each other, and with the resultant deflections which are appreciable at the top of the tank, also at right angles, it is almost impossible to prevent large cracks from forming at the corners. This criticism does not hold good when circular or elliptical construction is employed.

Description of Design

The reservoir as built is 200 ft. in diameter on the inside and 31 ft. deep in the center. The walls are supported by 50 buttresses, radially spaced. The deck is carried straight between the buttresses; thus the reservoir is not truly circular but a fifty-sided polygon. For a distance of 10 ft. below the water level the sides are carried down straight; below this point the sides are inclined at an angle of 45 deg. The bottom of the reservoir is a segment of a sphere, with a maximum ordinate of 5 ft. at the center.

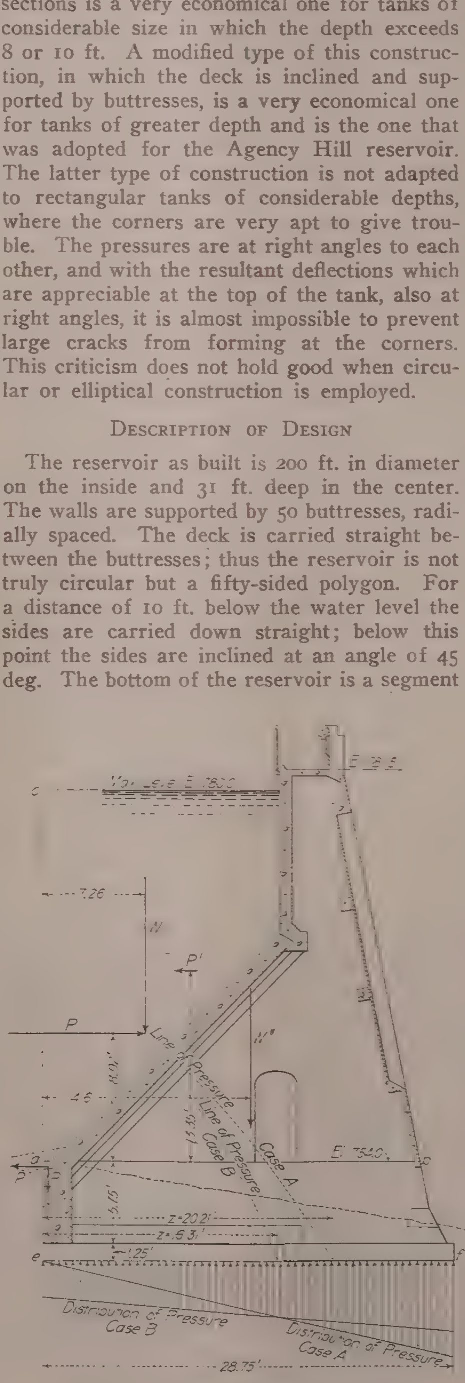


Fig. 1—Diagram of Wall Pressures

Practically all of the available water is stored above the surface of the ground. Only 580,000 gal., or 9.7 per cent of the total storage, are below the finished grade, and approximately 40 per cent is stored in the upper 10 ft., thus making it a very effective pressure-equalizing reservoir.

Fig. 1 shows the stresses acting on a portion of the dam subtending an angle of 7 deg. 12 min. at the center, all of which is supported by one buttress. The horizontal component P of the water pressure acts radially outward and amounts to 244,880 lb. Its line of action is 8.92 ft. above the line ab. The total weight of the water, W', resting on the inclined deck is 218,560 lb. with its line of action 7.26 ft. to the right of the line ac. The prismoidal form of the body of water resting on the inclined deck makes the computations, both for the amount of these pressures and their locations, somewhat involved.

The weight of the concrete section, W'', based on 145 lb. per cubic foot of concrete, amounts to 191,000 lb. Its center of gravity is 14.6 ft. from the line ac.

Assumptions

As several indeterminate factors enter into the computations necessary to determine the line of pressure in the buttress and the distribution of the foundation pressure over the footing course of each buttress, it was deemed best to compute the limiting values of these pressures under the following assumptions:

Case A.—Based on the assumption that each section must stand independent of its neighbor.

Case B.—Based on the assumption that the various sections are united into a monolithic structure and that all the forces resulting therefrom are taken into account to the full extent that they may be counted upon to develop in the structure.

The point where the resultant pierces the base, ef, under the assumption of Case A, can be obtained by taking moments about the point e, as follows:

$$\begin{aligned} 244{,}880 \times (8.92 + 5.75 + 1.25) &= 3{,}898{,}490 \\ 218{,}560 \times 7.26 &= 1{,}586{,}700 \\ 191{,}000 \times 14.60 &= 2{,}788{,}600 \\ \Sigma M &= 8{,}273{,}790 \end{aligned}$$

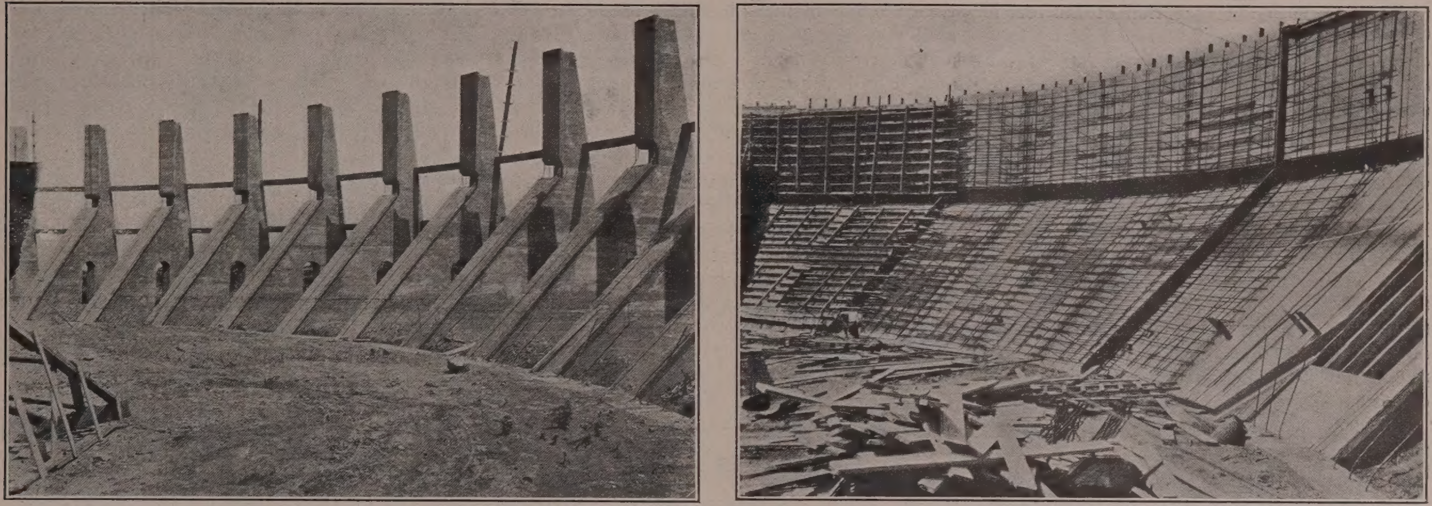
$$z = \Sigma M \div (W' + W'') = 8{,}273{,}790 \div 409{,}560 = 20.21$$

In this equation z is the distance from the line ea to the point where the resultant pressure on the foundation pierces the base.

The total width of the base is 28.75 ft. Therefore, the line of pressure falls 1.13 ft. outside of the middle third, thus making it appear that there will be considerable uplift at the heel of the buttress. This, however, is not the case. The total supporting area amounts to 117.65 sq. ft. Under the assumptions of Case A the maximum pressure at the toe would amount to 6727 lb. per square foot and the minimum to 29 lb. per square foot. There is no uplift whatever at the heel. If, instead of a spread footing, a rectangular-shaped footing of the same area were used, the maximum pressure in the footing would be 7,755 lb. per square foot, and the minimum, a tension of 795 lb. per square foot.

The line of pressure determined under Case A will not be the true line of pressure in the complete structure. In the complete structure, under the assumptions of Case B, a number of forces are developed, all of which add to the stability.

Prior to placing the concrete in the bottom of the reservoir further study of the problem



Concrete Buttresses Which Support Inclined Decking and Forms and Reinforcement for Slabs

indicated a probable weakness in the design of allowing the 6-in. bottom slab to span the refilled excavation made necessary in building the cut-off wall between buttresses. The plans of the bottom, therefore, were revised as follows, and as shown in Fig. 2.

To strengthen the structure, the reinforced concrete bottom rests upon and is tied into the face slab by steel reinforcement. The concrete bottom is reinforced with ⅜-in. bars spaced 12-in. centers. Seven feet from the wall the thickness of the concrete bottom was gradually increased from 6 in. to 15 in. directly over the supporting wall. The reinforcement in the bottom immediately adjacent to the wall consists of ⅜-in. square bars spaced 6 in. at the perimeter. The bottom is tied into the deck by ½-in. bars, 5 ft. long, spaced 12 in. on centers.

In Fig. 2 are shown all of the forces that act on this section. They are the weight of the water resting on the bottom with an intensity of p pounds per square foot, the supporting pressure of the foundation increasing from zero at the support to a maximum of p pounds per square foot x feet distant from the support; R, the reaction per lineal foot of the supporting wall, and P', the pull per lineal foot exerted by the side walls. This construction would add appreciably to the stability of the buttresses in transferring the line of pressure nearer to the center of the wall.

The distance x is limited by the strength of the bottom slab. Assuming a fiber stress of 20,000 lb. per square inch as the limiting stress that can be developed in the steel without permanently impairing the strength of the structure, we obtain a value of 6.28 ft. for x and a value of 3400 lb. for R. The force T is developed in the ½-in. bars spaced 12-in. centers along the perimeter of the bottom and can reach 5000 lb. per lineal foot without injury to the structure.

The need of some additional reinforcement of the bottom at this weak point of connection was apparent. As a substitute therefor all the excavated material disturbed by the construction of the toe of the deck slab was removed and the space filled with plain concrete and the original thickness of the bottom maintained. This not only required more concrete, but it effectually destroyed the function of the drain laid at the foot of the wall to prevent hydrostatic pressure from developing under the structure.

CIRCUMFERENTIAL REINFORCEMENT

The circumferential reinforcement of the structure consists of sixty-five ¾-in. bars, eleven ½-in. bars, and six ⅜-in. bars, giving a total cross-section of 39.97 sq. in. All of this reinforcement is lapped sufficiently at all connections so that the steel reinforcement of the shell can be considered to be practically continuous. There is every reason to believe that the diameter of the tank when filled with water will increase by ½ to 1 in. at the top. This expansion of the tank under pressure produces a stress of from 6250 to 12,500 lb. per square inch in the circumferential steel reinforcement.

Assuming the average stress in the ring tension due to the circumferential reinforcement to be 6000 lb. and to increase from 3000 lb. at the bottom to 9000 lb. at the top, the total outward pressure per lineal foot of tank thus resisted by the steel amounts to 2585 lb. The height at which the hydrostatic pressure per lineal foot of perimeter, p, acts can only be approximately determined. The center of gravity of the steel reinforcement is 11.5 ft. above the line ab and with the assumption as to the distribution of the pressure, the line of action of p is about 13.35 ft. above the line ab.

SYSTEM OF FORCES

In Fig. 1 are shown all of the forces acting on a portion of the dam supported by one buttress, when this section is considered to form a part of the complete structure. The additional forces acting on the section, due to the rigid connections, are P', R and P''. P'' represents the radial tension that may be developed by the steel reinforcement connecting the bottom with the inclined deck. The value of P'' may reach 5000 lb. per lineal foot, or 52,900 lb. per buttress, without injury to the structure. R represents the reaction of the bottom on the supporting wall. This may also attain 3400 lb. per lineal foot, or 35,900 lb. per buttress. The pressure P' under the assumptions made amounts to a maximum of 2585 lb. per lineal foot of circumference, or 31,600 lb. per buttress.

Taking moments about the point e of all the forces acting on the section, under Case B we have:

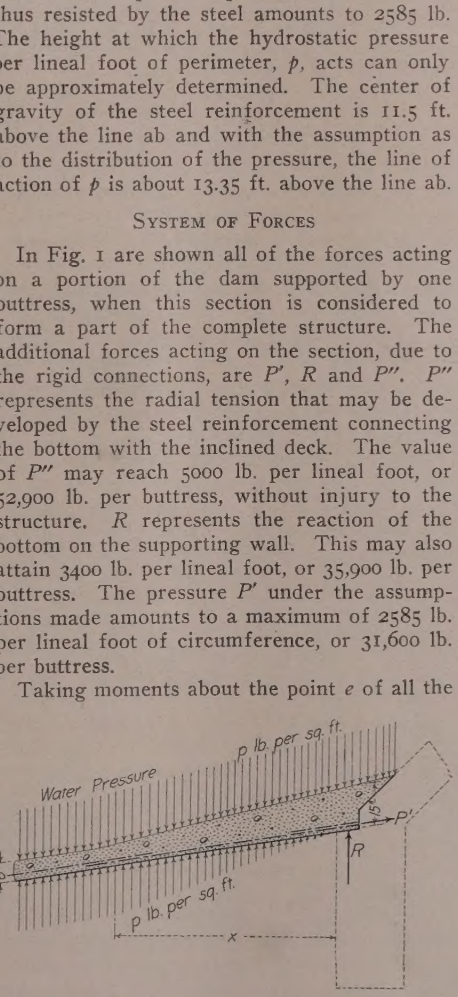


Fig. 2—Water Pressure at Base

$$
\begin{array}{llrr}
P & = 244{,}880 \times 15.92 & + 3{,}898{,}490 & \\
W' & = 218{,}560 \times 7.26 & + 1{,}586{,}700 & \\
W'' & = 191{,}000 \times 14.60 & + 2{,}788{,}600 & \\
P' & = 31{,}600 \times 20.35 & & - 643{,}060 \\
P'' & = 52{,}900 \times 7.00 & & - 370{,}300 \\
\hline
 & & + 8{,}273{,}790 & - 1{,}013{,}360 \\
 & & - 1{,}013{,}360 & \\
\hline
\end{array}
$$

$$\Sigma M' = 7{,}260{,}430 \text{ ft.-lb.}$$

$$\Sigma V' = W' + W'' + R$$

$$= 445{,}460$$

$$z = \Sigma M' / \Sigma V' = 16.31$$

Under Case B the pressure line cuts the base 16.31 ft. from the heel, well within the middle third. This gives a foundation pressure ranging from 4962 to 2544 lb. per square foot.

The foregoing computations show that the pressure at the toe of the buttress footing may range from 4962 to 6727 lb., and the minimum pressure at the heel from 29 to 2544 lb. These pressures are conservative for the character of the foundation upon which the footings are placed.

The buttresses, which are radially spaced, are 15 in. in thickness. At the point where the inclined deck starts there is considerable tension on the side of the buttress nearest the water. This tension is taken up by three ⅞-in. square bars at a unit stress in the steel of 9000 lb. per square inch, making full allowance for the weight of the section; ignoring this, the stress in the steel will be 15,000 lb. per square inch. Two ⅞-in. square bars are carried up along the face of the incline of the buttress to take care of any possible tensile stresses.

When the structure was about half completed the writer discovered an error that had crept into the plans which called for ⅜-in. square bars in the spread footings of the buttresses in place of ¾-in. square bars as required by the computations. The footings as constructed in the opinion of the writer do not give a sufficient factor of safety in adequately distributing the pressure over the area assumed in the design, and it was therefore deemed highly advisable to reinforce the spread footings. The writer regrets to state that the city officials failed to appreciate the importance of strengthening the footings, which could have been done at a nominal cost and would not have added more than 1 per cent to the total cost of the structure. In thus refusing to comply with the plans as developed by the writer they have assumed all responsibility for the structure.

The deck, with the exception of the top, is not tied into the face of the buttress by steel reinforcement. The vertical portion of the deck is 10 in. thick. The thickness of the inclined portion varies from 12 in. at the top to 15 in. at the bottom. The steel reinforcement is stressed to an average of 5200 lb. per square inch in the vertical portion of the deck and to 10,000 lb. in the lower or inclined portion. The deck of the reservoir is constructed as a monolith; no expansion joints are used.

The joint connecting the inclined to the straight portion of the deck, which is naturally a weak one, has been made a construction joint. It has been strengthened by a 12 x 16-in. concrete beam reinforced with four ¾-in. square bars.

No mention whatever has thus far been made of the possibility of hydrostatic pressure developing either under the concrete bottom or against the curtain wall, and thereby affecting the stability of the structure. This is guarded against by underdraining the spherical bottom with 4 and 6-in. tile drains. Five 4-in. lines of drains are laid radially and drain to a sump at the center of the reservoir.

To improve the appearance of the structure the buttresses are widened out to 3 ft. at the back, and between them a concrete curtain wall, 4 in. thick, is carried up for a distance of 4 ft. above the finished grade. Between the tops of the buttresses concrete arches are sprung. Each arch has a rise of 3 ft. and a clear span of 3 ft. less than the distance between the buttresses. The recess thus formed is filled at a depth of 12 in. with a thin curtain wall of stucco placed on Hy-Rib. At intervals of 5 ft. 7 in. the Hy-Rib is supported by reinforced-concrete beams. A concrete walk, 2 ft. 8 in. wide, extends around the entire reservoir. On the outside of the walk there is built a concrete railing in conformity with the architectural treatment of the reservoir.

Waterproofing

The only waterproofing called for in the specifications under which the reservoir was constructed was two coats of neat cement wash to be applied with a whitewash brush on the inside of the basin. The second coat must be applied before the first one has had time to get very hard.

The reservoir has been filled for a number of months to within 10 ft. of the top, and the leakage, as measured at the outlet of the underdrains, at no time has exceeded ½ gal. per minute. No leakage whatever is visible on the outside of the shell.

Approximate Estimate of Materials Needed for Structure

7,271 cu. yd. excavation, including grading, at	$0.55	$3,999.05
100 cu. yd. rock excavation	1.70	1,700.00
965 cu. yd. 1:2:4 concrete masonry	9.00	8,685.00
1,739 cu. yd. 1:3:6 concrete masonry	7.00	12,173.00
3,400 bbl. cement	1.50	5,100.00
189,900 lb. steel reinforcement	0.0425	8,070.75
650 lin. ft. parapet wall	1.40	910.00
196 lin. ft. 24-in. cast-iron pipe	5.40	1,058.40
215 lin. ft. 10-in. cast-iron pipe	2.00	430.00
110 lin. ft. 3-in. cast-iron pipe drain	0.50	55.00
12,300 lb. cast-iron specials	0.05	615.00
2 24-in. check valves	200.00	400.00
1 24-in. gate valve	240.00	240.00
1 10-in. gate valve	25.00	25.00
880 lin. ft. 4-in. tile drain	0.12	105.60
160 lin. ft. 6-in. tile drain	0.20	32.00
90 lin. ft. 12-in. vitrified pipe	0.70	63.00
1 strainer 24-in. outlet pipe	7.50	7.50
630 lin. ft. 1-in. pipe railing	0.40	252.00
500 lb. wrought iron	0.05	25.00
20,300 sq. ft. of stucco on hy-rib	0.15	3,045.00
Total contract price		$46,991.30

Horizontal construction joints are used freely. The unfinished surface of these was always left in as rough a condition as possible, but was never roughened up after the concrete had partially set. The writer's experience is that this roughening often loosens the stones in the partially set concrete, but not sufficiently so that the loose stones can be removed by brushes, a condition which is apt to impair the watertightness of the structure.

Vertical construction joints were permitted only over the buttresses, as such joints are very difficult to make watertight.

The table is an approximate estimate of the materials required for the structure, together with the contract unit prices.

The final estimate exceeded the bid price by a very small percentage. The contractor's profit on the work approximated 20 per cent, indicating a reasonably economic reservoir, yet one which presents a very attractive appearance.

Book Reviews

An ingenious and useful diagram from which simple beam problems can be solved direct has been worked out by H. R. Thayer, assistant professor of structural design at Carnegie Institute of Technology. The diagram and directions for its use are on a 9 x 12-in. sheet of stiff paper. The various systems of intersecting lines indicate spans, loads, moments, unit stresses and section moduli, and are readily followed. (New York, D. Van Nostrand Company. 20 cents.)

In the book review of "Principles of Irrigation Engineering," by F. H. Newell and D. W. Murphy, published in the Nov. 8 issue, page 532, the price of the book is given as $2. The price is $3.

Design of Plate Girders. By Lewis E. Moore, Associate Professor of Structural Engineering, Massachusetts Institute of Technology. Cloth, 6 x 9¼ in.; 285 pages; 82 illustrations; 40 tables. New York, McGraw-Hill Book Company, Inc. $3 net.

(Reviewed by Frank H. Constant, Professor of Structural Engineering, University of Minnesota)

In line with the demands of more scientific design in general the plate-girder has come in for its portion of the newer critical analysis, and in some cases the older, hard-and-fast methods of design have had to yield to more precise ones. The ordinary approximate rules have a distinct limitation to their accurate application, and only imperfectly apply to some cases and not at all to others. For example, the error in applying the so-called "effective-depth" method to heavy shallow girder design is considerable, while all long-span girders with unlike top and bottom flanges (of unsymmetrical cross-section relative to the neutral axis) can not be solved at all by rougher methods. The present volume recognizes the need for a more adequate treatment of the plate-girder—that most common and useful of all bridge types—and it is not a matter of surprise that the author has found material enough to dedicate an entire volume of 285 pages to its development. The book is in no sense a descriptive one, but is at all times actively concerned with the principles of design and their application to actual examples. The author states in his preface that the book has been written to explain clearly and in detail the reasons underlying designing, showing the assumptions made, and giving, so far as possible, various methods, with an indication of which is the best one in each case.

The subject of stresses has been condensed into one chapter, but the author finds space to tell practically all that is necessary for plate-girder design. The treatment is simple and clear and covers uniform and rolling loads, influence lines, wheel-load criteria and the use of the moment table. Chapter 2 gives a short and careful discussion of the efficiency of riveted joints. Chapter 3 develops the theory of the plate girder. An interesting feature of this chapter is the ingeniously simple relationships worked out between deflection, depth and fiber stress for all possible kinds of loading. These very simple formulæ permit one to determine the depth of beam required to keep the ratio of deflection to span length down to any predetermined amount, or to determine the allowable fiber stress for any given depth and deflection. In Chapter 4 the principles of design are now applied in complete detail to the design of a 45-ft. through span for E50 loading and the New York, New Haven & Hartford Railroad specifications of 1912. Chapter 5 contains a similar complete design of a 70-ft. deck girder for E60 loading, while Chapter 6 takes up the box girder. Here, even more than in the larger types of the preceding chapters, the necessity for precise methods is apparent. The proper location of the neutral axis and the computation of the moment of inertia and fiber stresses, whether for gross or net area of cross-section, or gross above and net below the neutral axis, are discussed, and the design of a typical three-webbed box girder of 19-ft. span with a 445,000-lb. center load is worked out by all three methods and the results compared. The reviewer regrets that the author did not add one more chapter to include the design of a heavy, long-span girder with unsymmetrical flanges, a type quite popular with some railroads and imperative for very long spans, and which admirably illustrates all of the more complex features of precise plate-girder design.

Chapter 7 has been written by Mr. John C. Moses, engineer of construction of the Boston Bridge Works, and is entitled "Shop Hints for Structural Draftsmen." He discusses at length the economic relation of the draftsman to the template, pattern, blacksmith and bridge shops, and to the erector, describing shop methods and the limitation of the tools, and the necessity for the draftsman to plan his work with reference to the needs of the shop and erection department, while at the same time carrying out the intentions of the designing engineer. He states, with justice, that such a man "may rightfully feel that he is an engineer and not a mere mechanic."

The general specifications for steel railroad bridges of the New York, New Haven & Hartford Railroad, 1912, are given in full, followed by forty tables intended to lighten the work of the designer. These pertain mainly to web, cover-plate and angle areas, moments of inertia for flange angles and cover plates for various girder depths, diagrams for stiffener spacing by several well-known formulæ, bearing the shearing values of rivets for all units varying by thousand pounds, and other useful tables.

The book is intended mainly as a text book for students, but the older engineer will find much in it to interest him. As a text book it is a distinct addition to engineering literature and will be welcomed by instructors. The author's style is clear and interesting and he displays good judgment in the choice of his material and the manner of its presentation. While rather emphasizing exact and scientific methods of design, a good balance is at all times maintained between theoretical considerations and practical necessity.

The typographical work is excellent throughout and, for a first edition, there are few typographical errors.

Break of Baffle Wall in Fort Smith Settling Basin

Rapid Draining of Tank, Prompted by Fear of Earth Slides, Causes Excess Head on One Side of Wall

EVIDENCES of an earth movement on the river side of the newly constructed settling basin at Fort Smith, Ark., on Oct. 26, made the employees apprehensive that the basin embankment was going to slide out. With the consent of the superintendent, but not of the resident engineer, they opened a drain valve which permitted the water to be drawn down so rapidly on one side of a central brick baffle wall that the upper portion of the wall collapsed. From information given by Mr. Wynkoop Kiersted, consulting engineer for the settling basin and new filtration plant, the following notes are taken:

Immediately after opening the drain valve the chief engineer of the pumping station, with three of his assistants, went out on the baffle wall and attempted to pull a boat through one of the overflow notches, and was thus engaged when the baffle wall collapsed, precipitating all into the water. One man was drowned.

The water supply is drawn from the Poteau River, which in itself is a subsiding basin for the first 10 miles, except when subject to backflow from the Arkansas River, into which it discharges at Fort Smith. There are probably two or three consecutive months in each year when the use of the basin could be dispensed with and water taken direct to the filters through a small coagulating basin attached to the filters. For this reason there was no occasion for a basin which could be emptied in sections. The baffle wall was designed for an 8-in. maximum difference of level in the adjoining divisions of the basin when full, and with the expectation that about twenty-four hours would be consumed in emptying the basin in order to avoid the hazard of any water imprisoned in the earth slopes causing slips of the inside slopes of the embankment or of the paving.

The basin had been in use about a month when the accident occurred and no instructions had been given to the attendants with regard to the controlling conditions in emptying the basin. It was not expected that any occasion for emptying the basin would arise without consultation with the resident engineer, who is still in charge of the work.

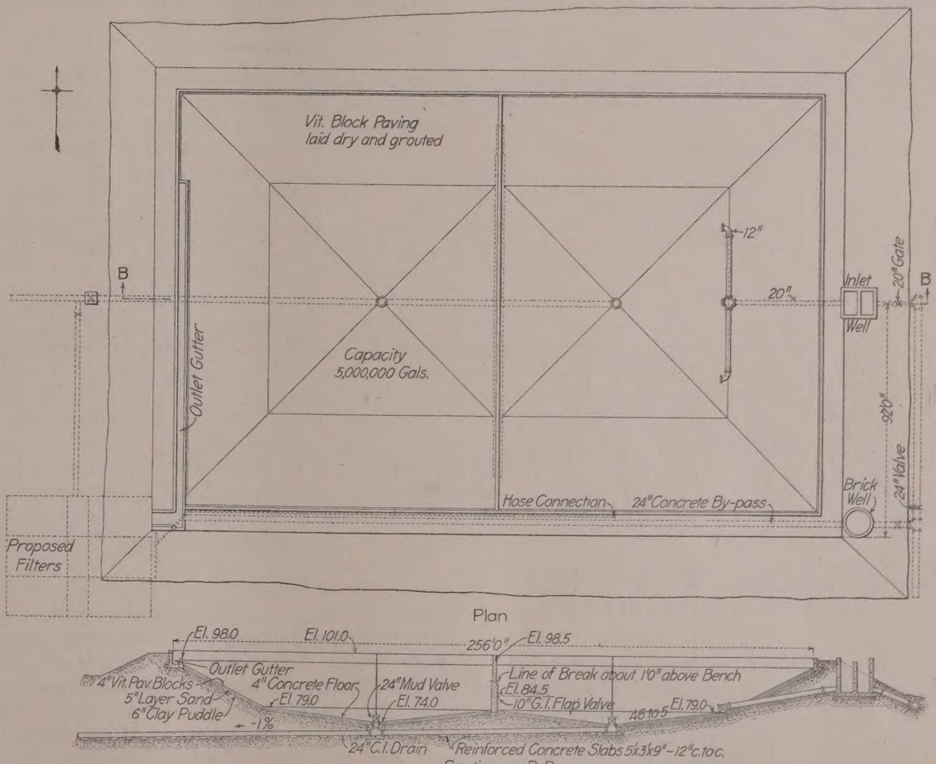
Object of Wall

The object of the wall across the middle of the settling basin is to provide facilities for introducing a coagulant after the water has deposited the heavy sediment in the east division of the basin. To have built solely for this purpose a wall strong enough to permit the emptying of either division of the basin independently was considered too expensive, as it would have cost $7000 or more. Therefore, the idea was conceived that a baffle wall would answer every practical purpose.

Four pipes through the baffle wall, at a level of about 5½ ft. above the bottom of the reservoir, admit of a discharge at the rate of about 6,000,000 gal. per twenty-four hours with an 8-in. difference of water level. As the water level in the basin falls the permissible difference of level becomes greater, and finally when the level of the water reaches the cross-pipes a difference of 5 or 6 ft. would be admissible.

Draining Basins

The 24-in. drain pipe from the basin to the river communicates with each of the two divisions of the basin by means of a 24-in. disk valve. The tower over the drain valve in the west division is built low, so as to compel the opening of the east valve when necessary to drain the basin. Otherwise, if the west valve were opened first, the flaps on the cross-pipes in the baffle wall would cut off communication between the two divisions. The discharge capacity of this 24-in. valve and 24-in. drain pipe under the pressure of a full basin is at the rate of about 35,000,000 gal. per day. It is not easy to control the rate of draining the basin by means of the disk valves, and for this reason a 24-in. stop gate was placed on the drain line outside of the west embankment—the idea being to set the disks of this stop gate at such a point that a rapid emptying of the basin would be impossible. The disks of this valve had not been set, as no occasion for the early draining of the basin was anticipated.

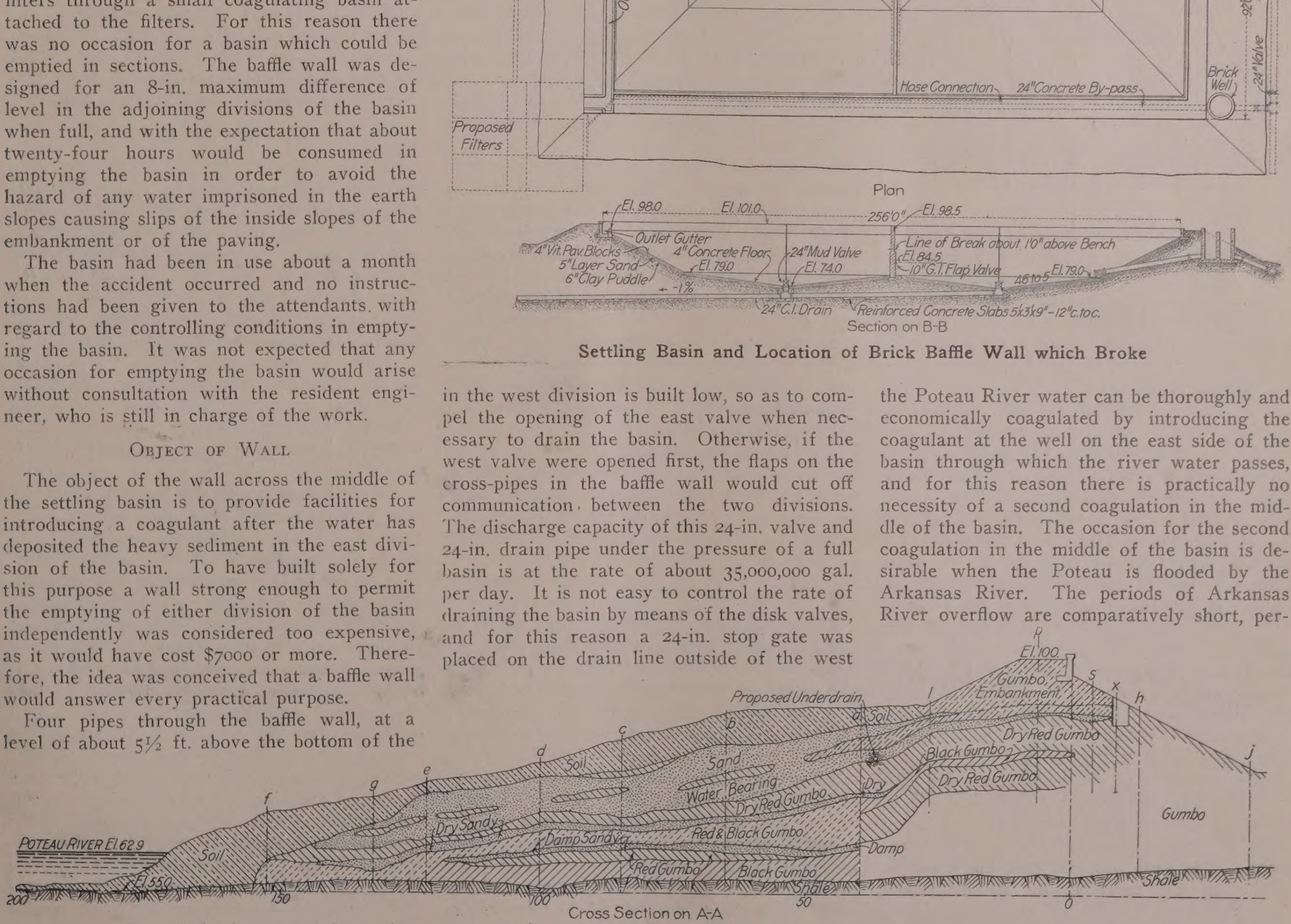


Settling Basin and Location of Brick Baffle Wall which Broke

Excess Head on Wall

When the disk valve in the east basin was raised almost to its full height the unobstructed discharge from the east basin so greatly exceeded the discharge from the west basin through the cross-pipes that the difference in level between the water on either side of the baffle wall soon passed the safety mark of 8 in. and pushed the lighter portion of the wall over. Mr. Kiersted states that there was no possible way of avoiding the accident with water passing out of the basin under full head and with a wide-open valve.

The short period that the settling basin has been in operation has shown very clearly that the Poteau River water can be thoroughly and economically coagulated by introducing the coagulant at the well on the east side of the basin through which the river water passes, and for this reason there is practically no necessity of a second coagulation in the middle of the basin. The occasion for the second coagulation in the middle of the basin is desirable when the Poteau is flooded by the Arkansas River. The periods of Arkansas River overflow are comparatively short, per-

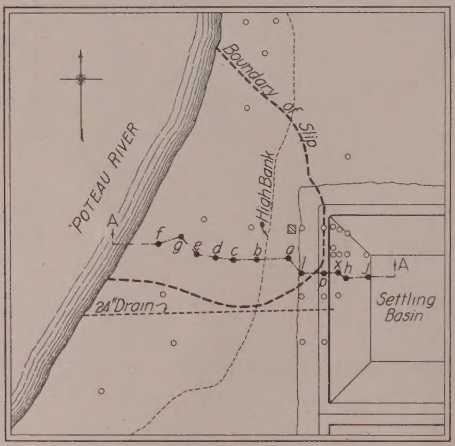


Cross-Section Showing Geological Formation on Line of Drill Holes Indicated in Plan on Page 620 haps not more than 10 per cent of the time, and therefore it seemed scarcely necessary to rebuild the baffle wall to its original height for this limited use only. Reconstruction of the wall was not recommended further than to repair the brickwork at both ends of the portion of the wall which remained upright.

Earth Cracks

Cracks in the earth between the Poteau River and the west bank of the settling basin indicated a movement of ground toward the river. No injury has been done to the basin, with the exception of a movement in the northwest corner of the outside slope.

The cross-section on page 619 shows the geological formation along an east and west line about 50 ft. from the northwest corner of the basin. None of the sections shows an abrupt rise of the shale underlying the Poteau River, and accordingly there is nothing to indicate a movement of the ground on the shale substratum. However, above the shale substratum there appear to be three distinct layers of sand separated by impervious gumbo. The two lower layers of sand are thin and practically free from water, and do not in any way seem to be responsible for any of the earth slips. The upper layer of sand, 4 or 5 ft. in thickness, appears to be sealed on the river side of the basin by a deposit of soil and gumbo. This upper layer of sand tails out to the eastward, but extends far enough to pass entirely under the embankment for a distance of 50 to 75 ft. from the northwest corner of the settling basin.



Plan Showing Boundary of Slip

The theory advanced by Mr. Kiersted is that dry-weather cracks in the surface soil permit rain water to enter the upper layer of sand, where it remains pocketed, and finally when the sand becomes saturated the pressure induced by the imprisoned water, equivalent to a head of 10 to 15 ft., causes the superimposed layers of soil and gumbo to yield along the line of least resistance, which, of course, is downward and toward the river.

Evidently this condition has existed for years, as indicated by previous movements of the ground along the river front for a distance of fully 150 ft. north and 150 ft. south of the northwest corner of the settling basin.

There is no evidence whatever, in Mr. Kiersted's opinion, that the settling basin is primarily the cause of the earth slips, although it probably is a contributing cause because of the thin layer of sand which has an outcrop along the inside slope of the west embankment. It is quite probable that this layer of sand was not entirely cut off or sealed during the construction of the embankment, and in all probability admitted some water into the pocket of sand intervening between the settling basin and the river.

Recommendations for remedying the trouble are to seal the sand outcrop along the inside slopes of the basin and to underdrain the sand pocket outside of the outer slopes of the basin. In order to protect the drain and the sand pocket deposits from flooding by backwater during high stages of the river, the underdrain should discharge into the drain well. The drain well should be kept free of water by an independent pipe connected with the basin drain pipe on the river side of the valve and communicating with the interior of the valve well, and protected from river backflow by a back-pressure valve and also by a stop valve for hand manipulation.

Plans for Federal Valuation of Common Carriers

Preliminary Organization, Division into Districts, Appointment of District Engineers, and Other Lines of Progress

The Interstate Commerce Commission will have an extensive organization in order to comply with the act of Congress directing the valuation of railways and other interstate agencies of commerce over which it has jurisdiction. The organization is still far from complete, but the commission has made much progress with the plan and has perfected the general outlines of the methods which will be followed.

The work of valuation will be directly in charge of Charles A. Prouty, of Vermont, who has presented his resignation as a member of the commission to President Wilson in order that he may take up his new duties. He will be known as the director of valuations and, subject to the Interstate Commerce Commission, will have complete authority over all features of the work. The organization in this branch of the commission's activities will report to him.

The general lines of this organization were considered carefully by the commission in conference with a temporary advisory committee which has now completed its labors and will not have active connection with the work itself. This advisory committee was composed of Charles F. Staples, member of the Minnesota Railroad and Warehouse Commission; Prof. Edward W. Bemis, of Chicago; Prof. Henry C. Adams, of Ann Arbor, Mich., formerly statistician of the Interstate Commerce Commission; John Lancaster Williams, Assistant Secretary of the Treasury, and Oscar T. Crosby, of Wilmington, Del. It is the intention to create another advisory or advising committee to discuss questions with the commission as they arise in the future, but the personnel of this committee has not been entirely decided.

Advisory Board

The commission will make every effort to surround itself with men who have given attention to the matters of railroad regulation and valuation. It is expected that Mr. Staples, who has had long experience as a member of the Minnesota commission, will be a member of the new advisory board. In view of the appointment by the steam railroads of leading attorneys to represent them in the legal aspects of the subject, the commission felt that it would be desirable to have an attorney to represent it in all phases of the valuation from the beginning. With that object in mind the commission has asked John H. Roemer, chairman of the Railroad Commission of Wisconsin, to take this office, and Mr. Roemer now has the matter under consideration.

The work of valuation will be handled by the commission through a regularly constituted division of valuation corresponding to other divisions in the organization of the commission, such as the division of statistics, the division of accounts, etc. The direction of the engineering organization will be in charge of the board of engineers—E. F. Wendt, Prof. W. D. Pence, R. A. Thompson, J. S. Worley and Howard M. Jones—appointed directly by the commission. Each will be in direct charge of one of the five districts into which the commission has divided the country for the purpose of facilitating the work.

Districts

Mr. Wendt will be stationed at Washington and will have the direction of the Eastern District, comprising Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia. Professor Pence has made his headquarters at Chicago and will have charge of the Central District, comprising Arkansas, Illinois, Iowa, Louisiana, Michigan, Minnesota and Wisconsin. Mr. Worley has his headquarters at Kansas City and will have charge of the Western District, comprising Colorado, Indian Territory, Kansas, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota and Texas. Mr. Thompson, with headquarters at San Francisco, will have charge of the Pacific District, including Alaska, Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming. Mr. Jones, located at Chattanooga, Tenn., will direct the work in the Southern District, comprising Alabama, Florida, Georgia, Indiana, Kentucky, Mississippi, Ohio, Panama, Porto Rico, South Carolina and Tennessee. Each of these districts includes about 50,000 miles of track.

District Engineers

As it is expected that the supervisory and consulting duties of members of the board of engineers will require their presence at Washington frequently for conference, the commission has appointed a district engineer to take direct charge of the work of each district. These district engineers are as follows: For the Eastern District, Frank Rhea; for the Central, D. V. Moore; for the Western, Carl C. Witt; for the Pacific, F. L. Pitman, and for the Southern, John Y. Bayliss. With this method of organization no delay will result from the necessary absence of members of the board of engineers from their respective territories.

The headquarters of the division of valuation will be located in a building one block from the headquarters of the Interstate Commerce Commission, which was formerly occupied by the division of statistics and accounts.

Pending the completion of the organization the commission has been giving consideration to a general plan of work and to such initial steps as should be taken to prepare for the greater task of the future. Under date of Aug. 1, the commission issued a tentative draft of regulations for maps and profiles, asking carriers for suggestions for modifications. The second tentative draft was issued under date of Oct. 2 and this requested carriers to offer such criticism and suggestions regarding the regulations as might be helpful to the commission in the preparation of the final specifications for authoritative issue. It expected therefore that the final authoritative specifications will be issued within a short time.